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## **2010 Ambient Air Monitoring Network 5-Year Assessment**

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# **I. INTRODUCTION AND SUMMARY**

## **I. A Introduction**

This document is the Massachusetts Department of Environmental Protection's (MassDEP's) first Air Monitoring Network 5-Year Assessment required pursuant to 40 CFR 58.10(d). The Federal Clean Air Act established a joint Federal-State partnership for protecting the quality of our nation's air. A key component of this partnership is the national system of ambient air quality monitors. State and local air pollution control agencies maintain a network of air monitoring stations that measure ambient concentrations of pollutants for which the U.S. Environmental Protection Agency (EPA) has established a National Ambient Air Quality Standard (NAAQS). Those pollutants, which are known as "criteria pollutants," include ozone (O<sub>3</sub>), particulate matter smaller than 10 microns (PM<sub>10</sub>), particulate matter smaller than 2.5 microns (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), carbon monoxide (CO), and lead (Pb). The monitoring network is designed to determine if air quality meets the NAAQS as well as to provide data needed to identify, understand, and address ambient air quality problems. EPA promulgates regulations that define minimum monitoring requirements as well as monitoring techniques and procedures.

Monitoring networks are designed to achieve, with limited resources, the best possible scientific data to inform the protection of public health, the environment and public welfare. The number, location, and types of monitors needed to achieve this goal depends on a myriad of factors including demographics, pollution levels, air quality standards, monitoring technology, budgets, and scientific understanding. These factors all change over time. In accordance with EPA monitoring regulations, state and local air pollution control agencies must conduct an assessment of their monitoring networks every 5 years in order to determine:

- if the network meets the monitoring objectives defined in Appendix D of 40 CFR 58.10,
- whether new monitoring sites are needed,
- whether existing sites are no longer needed and can be terminated, and
- whether new technologies are appropriate for incorporation into the ambient air monitoring network.

The network assessment must consider the ability of existing and proposed monitoring sites to provide relevant data for air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma). The assessment also must show the effects of proposals to discontinue any sites on data users other than the agency itself, such as nearby States and Tribes or organizations conducting health effects studies. For the criteria pollutant PM<sub>2.5</sub>, the assessment also must identify needed changes to population-oriented sites.

The network assessment must include:

- Re-evaluation of the objectives and budget for air monitoring,
- Evaluation of a network's effectiveness and efficiency relative to its objectives and costs, and
- Recommendations for network reconfiguration and improvement.

As discussed below, MassDEP believes it may have to make significant changes to its monitoring network to accommodate new SO<sub>2</sub> and NO<sub>2</sub> monitoring requirements in the face of fewer staff and a lower budget. The final decisions on how to site new monitors will depend upon available resources, an in-depth look at the technical requirements for locating the new sites, real-world options for locating them, and the extent to which existing monitors can be moved to meet the new requirements. Other factors including public input, site logistics, and a host of other considerations also will go into making these decisions.

## **I. B Summary and Conclusions**

The Air Assessment Branch within the MassDEP Bureau of Waste Prevention has maintained an ambient air quality monitoring network since it began collecting and analyzing particulate samples in the late 1950s. Since that time the network has grown to include 29 stations in 21 municipalities located in every county of the state except Franklin, Dukes, and Nantucket. The network monitors ambient concentrations of all criteria pollutants (for which EPA has established a NAAQS)) as well as ambient levels of toxic air pollutants and ozone precursors, which are substances that react in the atmosphere for form ground-level ozone, and meteorological conditions. The Massachusetts network meets and in many cases exceeds EPA's current minimum monitoring requirements.

### **I. B-1 NETWORK DESCRIPTION**

MassDEP operates two major categories of air monitors, "continuous" and "intermittent." Continuous monitors sample the air 24 hours per day, 7 days per week. Intermittent monitors take discrete samples for a specific time period at predetermined intervals. While samples are typically taken every third day or every sixth day, they can be taken at any other interval. Data is averaged in blocks of 1, 3, or 24 hours, depending on the regulatory requirement.

Some monitors, typically those measuring gaseous pollutants, perform the entire analysis automatically on-site. Others, such as the filter-based samples for lead, particulate matter 10 microns (PM<sub>10</sub>), particulate matter 2.5 microns (PM<sub>2.5</sub>), and some volatile organic compounds (VOCs) and toxics, require that staff collect samples in the field and bring them back to the laboratory for analysis.

The MassDEP air monitoring network contains the following monitors:

- Criteria pollutant monitors:
  - CO (carbon monoxide): 6 continuous monitors (2 are low-range that detect trace concentrations of CO)
  - NO<sub>2</sub> (nitrogen dioxide) / NO (nitric oxide) / NO<sub>x</sub> (total nitrogen oxides): 11 continuous monitors.
  - O<sub>3</sub> (ozone): 14 continuous monitors.
  - SO<sub>2</sub> (sulfur dioxide): 6 continuous monitors (2 are low-range)

- PM<sub>2.5</sub>: 15 intermittent “Federal Reference Method (FRM)” monitors that are used by EPA to make official determinations of whether or not the state is “in attainment” of the ambient air quality standard, and 10 continuous Beta Attenuation Monitors (BAMs) that can provide supplemental information on ambient PM<sub>2.5</sub> concentrations
- PM<sub>10</sub>: 6 intermittent monitors
- Pb (lead): 1 intermittent monitor
- Non-criteria pollutant monitors:
  - Ozone precursors at 6 Photochemical Assessment Monitoring (PAMS) stations:
    - NO<sub>y</sub> (total reactive oxidized nitrogen): 2 continuous monitors
    - VOCs and carbonyls: 4 continuous monitors using automated gas chromatographs (GCs) and 2 intermittent monitors using gas canisters
  - Black carbon: 3 continuous monitors measure this form of light absorbing carbonaceous particulate matter
  - Toxics: 2 intermittent monitors measure toxic VOCs, toxic metals, polycyclic aromatic hydrocarbons (PAHs) and black carbon.
  - Speciation of PM<sub>2.5</sub>: 2 intermittent monitors measure the individual constituents of PM<sub>2.5</sub>, including elements, sulfates/nitrates, and organic carbon
  - PM<sub>10</sub> toxic metals : 1 intermittent monitor measures these particles
- Meteorological monitors measuring atmospheric conditions that influence air pollution levels:
  - Wind speed and direction (WS/WD): 13 monitors
  - Relative humidity (RH): 13 monitors
  - Precipitation: 2 monitors
  - Atmospheric pressure (i.e., barometric pressure): 13 monitors
  - Solar radiation: 13 monitors
  - Ambient temperature: 14 monitors
  - Upper Air Profiler: 1 Profiler measures wind speed/wind direction and temperature at various altitudes, which aids in the analysis of pollutant transport

## **I. B-2 MASSACHUSETTS AIR QUALITY AND EMISSIONS 1990 - 2005**

In the 40 years since the passage of the Clean Air Act, air quality in Massachusetts has gone from not meeting the standards for particulates, sulfur dioxide, lead, ozone, and carbon monoxide in all or part of the state to attaining the standards for all pollutants except for ozone.

This improvement in air quality has resulted from the combination of air pollution controls on industrial operations and vehicle emissions, limits on the sulfur and ash content of fuels, and limits on the VOC content of many consumer products, industrial inks, adhesives, solvents, and architectural coatings. A decline in Massachusetts manufacturing activity and an associated 67% drop in the number of major air pollution sources in the state since 1990 also have contributed to a reduction in emissions.

Data for Massachusetts in the most recent National Emissions Inventory (NEI) show that between 1990 and 2005 emissions of criteria pollutants and their precursors have declined despite increased population and vehicle miles travelled. Specifically,

- VOC emissions have declined 38%
- NO<sub>x</sub> emissions have declined 29%
- CO emissions have declined 41%
- SO<sub>2</sub> emissions have declined 66%
- PM<sub>2.5</sub> emissions have declined 31%<sup>1</sup>

## **I. B-3 CONCLUSIONS AND POSSIBLE NETWORK CHANGES**

The Massachusetts air monitoring network currently reflects an emphasis on monitoring ozone levels, the one pollutant for which Massachusetts does not attain the NAAQS. The network is designed to measure the concentrations of ozone and its precursors in-state, as well as provide insight into ozone formation and the transport of ozone and its precursors into and out of the state. Monitors also are situated to develop an understanding of the variations of PM<sub>2.5</sub> levels within the state, a pollutant Massachusetts is watching closely because of the potential for occasional exceedances of the standard in some parts of the state.

MassDEP has sited its monitors in accordance with EPA guidelines and requirements for characterizing micro-scale (up to 100 square meters), middle-scale (a few city blocks), neighborhood (up to 4 square kilometer), urban (a city), and regional (up to hundreds of square kilometers) air quality and for measuring the greatest population exposures and the highest exposures.

Based on analysis of post-2000 changes in population and emissions, MassDEP believes that changes in these factors do not indicate a need to reconfigure the existing monitoring network. County-by-county review of the data shows that emissions have decreased fairly uniformly across the state. The growth in population and vehicle miles travelled also has been fairly uniform across the state. Massachusetts' population centers remain the same, although they are larger; the road network is relatively unchanged, although it is carrying more vehicles; and stationary sources of pollution are still distributed in roughly the same pattern, although they emit less and there are fewer of them. The absence of major shifts in these three factors indicates that an adjustment to the basic configuration of the air monitoring system is not warranted.

In addition, review of the distribution of children and of the incidence of various diseases associated with air pollution (such as asthma, respiratory disease, lung cancer, and circulatory diseases), as well as environmental justice populations, indicates that the existing distribution of monitoring sites adequately supports air quality characterization in areas with high numbers of sensitive populations. The only possible exception is PM<sub>2.5</sub> monitoring in Barnstable County and

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<sup>1</sup> Based on EPA extrapolations from historic total suspended particulate (TSP) and PM<sub>10</sub> data. PM<sub>2.5</sub> was reported for the first time in the 2002 NEI, submitted by MassDEP to EPA in 2007.

the Franklin/Northern Worcester county area along Route 2. Asthma rates are higher than the statewide average in these areas, although they are less populated than other areas in the state.

Review of the current monitoring network against EPA's minimum monitoring requirements indicates that the network meets or exceeds the current minimum requirements for ozone, PAMS, lead, PM<sub>2.5</sub>, PM<sub>10</sub>, PM Speciation, and (and soon to be) PM<sub>coarse</sub>. However, recent changes to EPA's lead, SO<sub>2</sub>, and NO<sub>2</sub> NAAQS and associated monitoring requirements means that by 2013 MassDEP will need to add monitoring sites. EPA recently promulgated new 1-hour standards for NO<sub>2</sub> and SO<sub>2</sub> (and also may further lower the PM<sub>2.5</sub> standard).

Specifically, MassDEP will need to:

- Establish 2 new roadway NO<sub>2</sub> monitoring sites in the Boston/Cambridge/Quincy CMSA,
- Establish 1 new roadway NO<sub>2</sub> monitoring site in the Worcester CMSA,
- Establish 1 new roadway NO<sub>2</sub> monitoring site in the Springfield CMSA, and
- Establish an agreement between RI and MA on the location of 1 new roadway and 1 new community wide NO<sub>2</sub> monitoring site in the Providence Fall River New Bedford CMSA.

In addition MassDEP may need to:

- Establish 1 new SO<sub>2</sub> monitoring site in Barnstable County depending on whether the Canal Electric power plant is operated at its capacity, and
- Install Lead monitors around sources if emissions inventory indicates that there are sources greater than 0.5 tons per year. MassDEP is working with EPA to determine if any general aviation airport exceeds this threshold.

An analysis using analytical tools EPA developed for use by states in preparing their Network Assessments also reveal that Barnstable and Franklin Counties are potential gaps in the existing PM<sub>2.5</sub> monitoring network.

The need for additional monitors comes in an era of resource constraints including declining staff and funding. MassDEP has lost approximately 10% of its air monitoring staff since July 2008 due to state funding constraints. Further reductions are possible as the state continues to address its fiscal situation.

It costs an estimated \$125,000 to establish a new modestly outfitted total site, including 3 continuous monitors and one PM<sub>2.5</sub> FRM, and about 0.5 FTEs and \$16,000 annually to operate it. This does not include the extensive investment of staff time in identifying potential sites, negotiating with the owner for permission to locate a monitoring station, contracting with vendors for site preparation, construction, and equipment procurement and installation. Adding an additional monitor to an existing site is less costly at approximately \$11,000 for equipment and set up, and about an additional 0.1 FTE to operate it. However it does not appear that any of MassDEP's existing monitoring sites meet the criteria for NO<sub>2</sub> roadway monitoring, so these sites are likely to be entirely new.

MassDEP is looking for opportunities to streamline current operations by examining travel routes, maintenance schedules, and further reliance on automated continuous monitors for a number of parameters. Specifically, this includes an assessment of the feasibility and the implications of converting some or all of the FRM PM<sub>2.5</sub> samplers to FEM BAMs and participation with EPA and other states in reevaluating the PAMS network and associated measurement technologies. These assessments need to account for capital and operational costs, as well as siting considerations. In recent years, it has become increasingly difficult and expensive to site a new monitoring station, which would be required for the new SO<sub>2</sub> and NO<sub>2</sub> continuous monitors.

## **I. B-4 NEXT STEPS**

This network assessment brings together much of the information and data that will be needed to make the difficult choices MassDEP faces. MassDEP has run the tools that EPA has developed for identifying potential new sites for all PM and ozone monitors in the state. These tools consider correlations between existing site measurements, distance between sites and the likelihood of the site exceeding a standard, evaluating the correlation between site measurements, and evaluating the removal bias (i.e., the difference between the measured concentrations at a site and those that would be estimated for that site based on data from surrounding sites), and mapping the voronoi polygons that show the coverage area of each monitor. (A voronoi polygon is the shape formed when you draw a line equidistant between each monitor and each of the monitors closest to it.)

The final decisions on siting new monitors, moving monitors, changing equipment, or other changes to the monitoring network and our operating procedures will depend upon available resources, an in-depth look at the technical and logistical requirements for site locations, real-world options for locating them, the extent to which existing monitors can be moved to meet the new requirements, impacts on day-to-day operations, public input, and a host of other considerations.

## **II. NETWORK DESCRIPTION AND PURPOSE**

The MassDEP ambient air monitoring network is managed by the Air Assessment Branch (AAB) in MassDEP's Bureau of Waste Prevention.

### **II. A Network Description**

Since the late 1950s when Massachusetts began collecting particulate samples, the air monitoring network has grown to its present multi-pollutant, multi-station network that fully meets or exceeds current EPA standards for air quality monitoring. Looking ahead, MassDEP will need to expand its network by 2013 to meet newly adopted SO<sub>2</sub> and NO<sub>2</sub> NAAQS. Exhibit 2-1 shows the location of each monitoring site operated by the Air Assessment Branch.

## Exhibit 2-1



## II. A-1 NUMBERS AND TYPES OF MONITORS

MassDEP operates 29 monitoring stations (16 of which measure more than one air pollutant) located in 21 cities and towns, with at least one monitoring station in each county except for Franklin, Dukes (Martha's Vineyard), and Nantucket.

### Monitor Descriptions

There are two basic types of monitoring systems.

- Continuous Monitors that perform complete, automated analysis onsite and:
  - measure air quality 24 hours per day and report the data as hourly means. This technique is typically used for gaseous pollutants such as sulfur dioxide (SO<sub>2</sub>) nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), and ozone (O<sub>3</sub>) analyzers

Or

- perform analyses onsite after a sample has been taken, such as Photochemical Assessment Monitoring (PAMS) automated gas chromatographs (AutoGC) and PM<sub>2.5</sub> Beta Attenuation Monitors (BAM)
- Intermittent Monitors that procure discrete samples that are collected and brought to the laboratory for analysis, such as volatile organic compounds (VOCs) canisters and PM<sub>2.5</sub> filter samples. Depending on the regulatory or analytical requirements, samples may be

taken every day, every third day, every sixth day, or on some other prescribed schedule. The data are averaged in 3- or 24-hour intervals, according to a predetermined schedule based on EPA requirements for that contaminant.

MassDEP is moving toward greater reliance on automated methods such as Beta Attenuation Monitoring (BAM) for PM<sub>2.5</sub> and automated gas chromatographs for VOCs at PAMS stations where possible.

Advantages of automated analysis in the field include real-time or near-time reporting of ambient air quality data that can be immediately reported to the public using data loggers and telemetry systems, a continuous record of air quality data 24 hours per day, seven days per week, and a reduction in labor costs because time does not have to be spent retrieving and analyzing the collection filters and canisters. However, continuous monitors are expensive and are subject to equipment failure that makes it necessary to have back-up equipment readily available, and unlike intermittent samplers that can be placed on rooftops or other compact locations, usually require climate-controlled shelters.

The MassDEP network contains the following monitors for criteria pollutants:

- CO: 6 continuous monitors (2 are low-range that detect trace concentrations)
- NO<sub>2</sub> (nitrogen dioxide) / NO (nitric oxide) / NO<sub>x</sub> (total nitrogen oxides): 11 continuous monitors.
- O<sub>3</sub>: 14 continuous monitors.
- SO<sub>2</sub>: 6 continuous monitors (2 are low-range)
- PM<sub>2.5</sub>: 15 intermittent “Federal Reference Method” (FRM) monitors that are used by EPA to make official determinations of whether or not the state is in attainment of the ambient air quality standard, and 10 continuous BAMs that can provide supplemental information on ambient PM<sub>2.5</sub> concentrations
- PM<sub>10</sub>: 6 intermittent monitors
- Pb (lead): 1 intermittent monitor

The MassDEP network contains the following monitors for other pollutants:

- Ozone precursors at six PAMS stations:
  - NO<sub>y</sub> (total reactive oxidized nitrogen): 2 continuous monitors
  - VOCs and carbonyls: 4 continuous monitors using autoGCs and 2 intermittent monitors using gas canisters
- Black Carbon: 3 continuous monitors measure this form of light absorbing carbonaceous particulate matter
- Toxics: 2 intermittent monitors measure toxic VOCs, toxic metals, polycyclic aromatic hydrocarbons (PAHs) and black carbon.
- Speciation of PM<sub>2.5</sub>, nitrates, and organics. 2 intermittent monitors measure the individual constituents of PM<sub>2.5</sub>, including elements, sulfates, nitrates, and organic carbon
- PM<sub>10</sub> toxic metals : 1 intermittent monitor measures these particles

Meteorological monitors measuring atmospheric conditions that influence air pollution levels:

- Wind speed and direction (WS/WD): 13 monitors
- Relative humidity (RH): 13 monitors
- Precipitation: 2 monitors
- Atmospheric pressure (i.e., barometric pressure): 13 monitors
- Solar radiation: 13 monitors
- Ambient temperature: 14 monitors
- Upper Air Profiler: 1 Profiler measures wind speed/wind direction and temperature at various altitudes, which aids in the analysis of pollutant transport

Twelve of MassDEP's 29 monitoring stations measure only one air contaminant:

- 1 CO-only station
- 5 PM<sub>2.5</sub>-only stations
- 6 O<sub>3</sub> stations (although 4 of these also collect meteorological data)

### **Industrial Monitoring Network**

Certain industries monitor air quality and submit data to MassDEP. The data must be collected using quality assurance procedures established by MassDEP and EPA. There are four such monitoring stations in the Boston area. These stations measure Total Suspended Particles (TSP), SO<sub>2</sub>, sulfates (SO<sub>4</sub>), and WS/WD. One site in South Boston also measures NO<sub>2</sub>.

## **II. A-2 QUALITY ASSURANCE AND CONTROL**

### **Quality Control**

Whether measurements are continuous or intermittent, all analyzers must be tested to ensure data validity, accuracy and precision, and to ensure that the analyzer is operating properly and can be expected to continue to operate in an acceptable manner. A large portion of AAB staff time is spent calibrating equipment, challenging equipment performance in the field, and reviewing the quality of air monitoring data.

### **Quality Assurance**

The Air Assessment Branch has an active, independent Quality Assurance Section that ensures that proper data collection and analysis procedures are followed, equipment is maintained appropriately, and equipment is calibrated properly using the appropriate test gases. This QA Section performs periodic performance and systems audits at air monitoring sites throughout the network. This is essential to operating the monitoring network, analyzing samples, and producing air quality of sufficient quality to satisfy the needs of users.

## II. A-3 MONITOR SITING

Appendix D of 40 CFR Part 58 defines spatial monitoring scales that are useful in describing the purpose of individual monitors at specific locations:

- **Micro scale** – Concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters. Examples include the Kenmore Square and Lowell CO monitors, where the sample inlet is several feet or yards from a travel lane of a roadway and the influence of the emissions is not expected to spread much beyond the immediate area.
- **Middle scale** – Concentrations typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometers. Monitors at this scale characterize local conditions, similar to micro scale, but for a larger surrounding area. Examples include urban PM<sub>10</sub> monitors.
- **Neighborhood scale** – Concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range. This might be an urban area influenced by a major point source or area sources (for example, the Fall River SO<sub>2</sub> monitor) or the air quality surrounding a defined area of similar conditions (for example, Boston-Harrison Avenue as an urban background location or as an ozone monitoring site).
- **Urban scale** – Overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one monitoring site. Ozone networks around Boston, Worcester and Springfield are partially laid out on an urban scale.
- **Regional** – Usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers. Examples include monitors in Ware and Truro.

In general, Massachusetts air monitoring stations are sited to characterize one of the following:

- highest expected concentration in an area
- general background levels
- general population exposure
- welfare impacts
- pollutant transport

MassDEP does not currently run monitors sited to track pollution from individual point sources, however, the privately run industrial monitoring sites were established to track individual power plant emission sources. Most MassDEP monitoring activities are mandated by EPA regulations and guidelines. MassDEP works very closely with EPA to make sure that Federal air monitoring initiatives are implemented in Massachusetts.

## II. A-4 MONITORING SITE DETAILS

A full list of the Massachusetts monitoring stations, their locations, when they were established, their purpose, what they measure, and the equipment used are presented in the three Exhibits below.

Exhibit 2-2: MassDEP Air Monitoring Site Descriptions

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR MONITOR	YEAR ESTABLISHED	MSA/CMSA
25-003-4002	ADAMS	BERKSHIRE	MT. GREYLOCK	Regional	Highest Concentration	5/1/1989	Pittsfield MSA
25-015-0103	AMHERST	HAMPSHIRE	NORTH PLEASANT	Urban	Population Exposure	4/1/1988	Springfield MSA
25-025-0002	BOSTON	SUFFOLK	KENMORE SQUARE	Middle	Highest Concentration Population Exposure	1/1/1965	Boston CMSA; Boston Metropolitan MSA
25-025-0027	BOSTON	SUFFOLK	ONE CITY SQUARE	Middle	Highest Concentration Population Exposure	1/1/1985	Boston CMSA; Boston Metropolitan MSA
25-025-0041	BOSTON	SUFFOLK	LONG ISLAND	Urban	PAMS: Boston Type 2A (Maximum precursors) Others: Area Background	12/1/1998	Boston CMSA; Boston Metropolitan MSA
25-025-0042	BOSTON	SUFFOLK	HARRISON AVENUE	-CO: middle scale -Others: Neighborhood	Population Exposure	12/15/1998	Boston CMSA; Boston Metropolitan MSA
25-025-0043	BOSTON	SUFFOLK	174 NORTH STREET	Middle	Population Exposure Maximum Concentration	1/1/2000	Boston CMSA; Boston Metropolitan MSA
25-023-0004	BROCKTON	PLYMOUTH	120 COMMERCIAL ST	Neighborhood	Population Exposure	12/15/1998	Boston CMSA; Brockton MSA
25-013-0008	CHICOPEE	HAMPDEN	ANDERSON ROAD	Urban	PAMS: Springfield Type 2 (Maximum Precursor) Others: Population Exposure	1/1/1983	Springfield MSA
25-005-1002	FAIRHAVEN	BRISTOL	LEROY WOOD	Regional/ Urban	Population Exposure	1/1/1982	Boston CMSA
25-005-1004	FALL RIVER	BRISTOL	GLOBE STREET	Neighborhood	Highest Concentration Population Exposure	2/1/1975	Providence-Pawtucket-Fall River MSA
25-009-5005	HAVERHILL	ESSEX	WASHINGTON STREET	-PM <sub>2.5</sub> : Neighborhood -Others: Urban	Population Exposure	7/19/1994	Boston CMSA; Lawrence MSA

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR MONITOR	YEAR ESTABLISHED	MSA/CMSA
25-009-6001	LAWRENCE	ESSEX	WALL EXPERIMENT STATION	Neighborhood	Population Exposure	4/3/1999	Boston CMSA; Lawrence MSA
25-017-0007	LOWELL	MIDDLESEX	OLD CITY HALL	Middle	Maximum Concentration Population Exposure	7/17/1981	Boston CMSA; Lowell MSA
25-009-2006	LYNN	ESSEX	390 PARKLAND	Urban	PAMs: Boston Type 2 (Maximum Precursor) Ozone: Population Exposure	1/1/1992	Boston CMSA; Boston Metropolitan MSA
25-021-3003	MILTON	NORFOLK	MILTON MA, BLUE HILL	Urban	PAMS: Boston Type 1 (Upwind Background) PM <sub>2.5</sub> , & Ozone: Maximum Concentration	4/2/2002	Boston CMSA; Boston Metropolitan MSA
25-009-4005	NEWBURYPORT	ESSEX	261 NORTHERN BLVD	Urban	PAMS Boston Type 3 (Maximum Ozone Concentration) Others: Population Exposure	6/2010 (note this replaces the NEWBURY site)	Boston CMSA; Boston Metropolitan MSA
25-003-5001	PITTSFIELD	BERKSHIRE	78 CENTER STREET	Neighborhood	Population Exposure	12/1/1998	Pittsfield MSA
25-003-0006	PITTSFIELD	BERKSHIRE	1 SOUTH STREET	Neighborhood	Population Exposure	12/1/2005	Pittsfield MSA
25-013-0016	SPRINGFIELD	HAMPDEN	LIBERTY STREET	Neighborhood	Population Exposure Maximum Concentration	4/1/1988	Springfield MSA
25-013-2009	SPRINGFIELD	HAMPDEN	1860 MAIN STREET	Middle	Population Exposure Maximum Concentration	1/1/2002	Springfield MSA
25-017-1102	STOW	MIDDLESEX	US MILITARY	Regional	Maximum Ozone Concentration Population Exposure	4/1/1998	Boston CMSA; Boston Metropolitan MSA
25-001-0002	TRURO	BARNSTABLE	FOX BOTTOM AREA	Regional	General / Background	4/1/1987	No MSA; Downwind Providence-Pawtucket, RI
25-027-0024	UXBRIDGE	WORCESTER	366 E. HARTFORD AVE.	Urban	Ozone Transport (state line upwind) Population Exposure	11/1/2008	Boston CMSA; Worcester MSA
25-015-4002	WARE	HAMPSHIRE	QUABBIN SUMMIT	Ozone: Urban PM: Neighborhood	PAMS: Springfield Type 3 (Maximum Ozone Concentration) Others: Population Exposure	6/1/1985	Springfield MSA
25-027-0015	WORCESTER	WORCESTER	WORCESTER AIRPORT	Urban	Ozone: Worcester/Springfield Interface Others: Population Exposure	5/7/1979	Boston CMSA; Worcester MSA

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR MONITOR	YEAR ESTABLISHED	MSA/CMSA
25-027-0016	WORCESTER	WORCESTER	2 WASHINGTON STREET	Middle Neighbor-hood	Population Exposure	10/1/2003	Boston CMSA; Worcester MSA
25-027-0023	WORCESTER	WORCESTER	SUMMER STREET	CO: Middle Scale Others: Neighbor-hood	Population Exposure	1/1/2004	Boston CMSA; Worcester MSA

### Exhibit 2-3: Site Measurements

SITE ID	CITY	ADDRESS	METEOROLOGICAL	POLLUTANTS
25-003-4002	ADAMS	MT. GREYLOCK		O <sub>3</sub>
25-015-0103	AMHERST	NORTH PLEASANT		O <sub>3</sub>
25-025-0002	BOSTON	KENMORE SQUARE	TEMP	CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> (LV), PM <sub>2.5</sub> (3-day)
25-025-0027	BOSTON	ONE CITY SQUARE		PM <sub>10</sub> (LV), PM <sub>2.5</sub> (3-DAY)
25-025-0041	BOSTON	LONG ISLAND	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , VOC (PAMS)
25-025-0042	BOSTON	HARRISON AVENUE	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , tCO, tSO <sub>2</sub> , Pb, NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>y</sub> , PM <sub>10</sub> (LV) (2), PM <sub>2.5</sub> (3 DAY) (2), BAM <sub>2.5</sub> , VOC (TOXICS), CARBONYLS (6th-DAY), BLACK CARBON -SPECIAL MONITORING: NCore, Speciation, PM10 (2: HV & TOXICS), PM <sub>coarse</sub> , Cr6+, PAHS
25-025-0043	BOSTON	174 NORTH STREET		PM <sub>2.5</sub> (2: 3 DAY & Daily), BAM <sub>2.5</sub> , BLACK CARBON
25-023-0004	BROCKTON	120 COMMERCIAL STREET		PM <sub>2.5</sub> (2) (3-DAY)
25-013-0008	CHICOPEE	ANDERSON ROAD	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3 DAY)(2), VOC (PAMS), CARBONYLS (PAMS) SPECIAL MONITORING: Speciation, tCO
25-005-1002	FAIRHAVEN	LEROY WOOD	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub>
25-005-1004	FALL RIVER	GLOBE STREET		SO <sub>2</sub> , PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub>
25-009-5005	HAVERHILL	WASHINGTON STREET	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub>
25-009-6001	LAWRENCE	WALL EXPERIMENT STATION		PM <sub>2.5</sub> (3-DAY)
25-017-0007	LOWELL	OLD CITY HALL		CO
25-009-2006	LYNN	390 PARKLAND	FULL MET & PRECIP	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> , VOC (TOXICS), VOC (PAMS), CARBONYLS (PAMS)
25-021-3003	MILTON	MILTON MA, BLUE HILL	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , BAM <sub>2.5</sub> , VOC (PAMS)
25-009-4005	NEWBURYPORT	261 NORTHERN BLVD	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , NOA, NO <sub>y</sub> , VOC (PAMS)
25-003-5001	PITTSFIELD	78 CENTER STREET		PM <sub>2.5</sub> (3-DAY)

SITE ID	CITY	ADDRESS	METEOROLOGICAL	POLLUTANTS
25-003-0006	PITTSFIELD	1 SOUTH STREET		BAM <sub>2.5</sub>
25-013-0016	SPRINGFIELD	LIBERTY STREET		CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (2) (3-DAY), BAM <sub>2.5</sub> , BLACK CARBON
25-013-2009	SPRINGFIELD	1860 MAIN STREET		Pb, PM <sub>10</sub> (LV), PM <sub>2.5</sub> (3-DAY)
25-017-1102	STOW	US MILITARY	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> <i>SPECIAL MONITORING: UPPER AIR PROFILER</i>
25-001-0002	TRURO	FOX BOTTOM AREA	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , IMPROVE, PM <sub>2.5</sub> (3-DAY)
25-027-0024	UXBRIDGE	366 E. HARTFORD AVE.	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub>
25-015-4002	WARE	QUABBIN SUMMIT	FULL MET & PRECIP	O <sub>3</sub> , tSO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , NOA, NO <sub>y</sub> , PM <sub>10</sub> (LV), IMPROVE, PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> , VOC (PAMS)
25-027-0015	WORCESTER	WORCESTER. AIRPORT	WS/WD, TEMP	O <sub>3</sub>
25-027-0016	WORCESTER	2 WASHINGTON STREET		PM <sub>2.5</sub> (3-DAY)
25-027-0023	WORCESTER	SUMMER STREET		CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> (LV), PM <sub>2.5</sub> (2) (3-DAY), BAM <sub>2.5</sub> ,
tCO = Trace Range Carbon Monoxide      tSO <sub>2</sub> = Trace Range Sulfur Dioxide				

Exhibit 2-4: Sampling and Analytical Methods For DEP Measurements

PARAMETER	WORKSHEET ABBREVIATION	SAMPLING METHODOLOGY	ANALYTICAL METHOD	SAMPLE FREQUENCY	COMMENTS
Ozone	O <sub>3</sub>	Continuous Instrument (field analysis)	Ultra Violet (UV) Light Photometry	Continuous/Hourly	
Carbon Monoxide	CO	Continuous Instrument (field analysis)	Gas Filter Correlation; Non-Dispersive Infrared (NDIR) Detection	Continuous/Hourly	
Sulfur Dioxide	SO <sub>2</sub>	Continuous Instrument (field analysis)	UV Fluorescence	Continuous/Hourly	
Nitric Oxide / Nitrogen Dioxide / Nitrogen Oxides	NO/NO <sub>2</sub> /NO <sub>x</sub>	Continuous Instrument (field analysis)	Chemiluminescence	Continuous/Hourly	Same instrument for NO, NO <sub>2</sub> , NO <sub>x</sub>
Total Reactive Oxidized Nitrogen	NO <sub>y</sub>				
Lead	Pb	High Volume	Acid Digestion; Atomic Absorption	1 Every 6th Day/24 hour	Harrison Ave only.
Particulate Matter 2.5 microns	PM <sub>2.5</sub>	Low Volume; Size Selective	Gravimetric	1 Every 3rd Day/24 hour	
Particulate Matter 10 microns	PM <sub>10</sub>	Low Volume; Size Selective	Gravimetric	1 Every 6th Day/24 hour	
Particulate Matter 2.5 microns Hourly	BAM <sub>2.5</sub>	Continuous Instrument (field analysis)	Beta Attenuation	Hourly	
Particulate Matter 2.5 microns Speciation	SPECIATION	Low Volume; Size Selective	ICP/MS /Ion Chromatography/ Total Carbon	1 Every 3rd Day/24 hour	Elements, Nitrates/Sulfates, Carbon on 3 filters.

PARAMETER	WORKSHEET ABBREVIATION	SAMPLING METHODOLOGY	ANALYTICAL METHOD	SAMPLE FREQUENCY	COMMENTS
Particulate Matter 2.5 microns Speciation	IMPROVE	Low Volume; Size Selective	IMPROVE Protocol	1 Every 6th Day/24 hour	Elements, Nitrates/Sulfates, Carbon on 3 filters. PM10 also; Ware and Truro only.
Black Carbon	BC	Continuous Instrument (field analysis)	Optical Transmittance	Continuous/Hourly	
Toxic Elements	HV Toxics	High Volume/PM10	ICP/MS	1 Every 6th Day/24 hour	Elements; Harrison Ave. Only
Toxic VOCs	VOCs (Toxics)	Passivated Canister	GC/MS	1 Every 6th Day/24 hour	Lynn/Harrison Ave Only; VOCs = Volatile Organic Compounds
Toxic Carbonyls	Carbonyls	DNPH on Silica Gel Traps	HPLC	1 Every 6th Day/24 hour	Lynn/Harrison Ave Only; Formaldehyde and Acetaldehyde
Chromium 6+	Cr6+	Coated Filter	Ion Chromatography	1 Every 6th Day/24 hour	Harrison Ave Only
Photochemical Assessment Monitoring Stations Volatile Organic Carbons	VOCs (PAMS)	Sub ambient Preconcentration (field analysis)	GC-FID	Hourly	Four PAMS Sites, PAMS Season (June-August) (Ware, Chicopee, Lynn, Newburyport)
Photochemical Assessment Monitoring Stations Volatile Organic Carbons	VOCs (PAMS)	Passivated Canister	GC-FID	8 3-hour Every 3 <sup>rd</sup> Day (Ozone Season)	Two Remaining PAMS Sites (Milton / Blue Hill, Long Island)
Photochemical Assessment Monitoring Stations Volatile Organic Carbons	VOCs (PAMS)	Passivated Canister	GC-FID	1 Every 6th Day/24 hour (Year Round)	Lynn and Chicopee
Polycyclic Aromatic Hydrocarbons	PAHs	Quartz Filter; PUF Cartridge	GC/MS	1 Every 6th Day/24 hour (Year Round)	Harrison Ave Only
Photochemical Assessment Monitoring Stations Carbonyls	Carbonyls (PAMS)	DNPH on Silica Gel Traps	HPLC	8 3-hour Every 3 <sup>rd</sup> Day (Ozone Season)	Lynn and Chicopee
Wind Speed / Direction	WS/WD	Continuous Instrument (field analysis)	Ultrasonic Sensors or Spot Reading	Hourly	Eleven Meteorological Sites in State
Solar Radiation	Solar	Continuous Instrument (field analysis)	Pyranometer	Hourly	Eleven Meteorological Sites in State
Relative Humidity	RH	Continuous Instrument (field analysis)	Electronic Sensor	Hourly	Eleven Meteorological Sites in State
Ambient Temperature	TEMP	Continuous Instrument (field analysis)	Electronic Thermister	Hourly	Eleven Meteorological Sites in State
Barometric Pressure	BP	Continuous Instrument (field analysis)	Electronic Sensor	Hourly	Eleven Meteorological Sites in State
Precipitation	Precip	Continuous Instrument (field analysis)	Tipping Bucket	Hourly	Ware and Lynn Only
Upper Air Wind	Upper Air Profiler	Hourly Instrument (field analysis)	Radar Vectoring	Hourly	Stow Only
Upper Air Temperature	Upper Air Profiler	Hourly Instrument (field analysis)	Acoustic/ Radar Vectoring	Hourly	Stow Only

## II. B NETWORK PURPOSE:

MassDEP's ambient air quality monitoring network serves many purposes. These purposes have changed over time as air quality has improved. They include:

- **Provide information about air quality to the public.** MassDEP issues a daily air quality forecast, including alerts if necessary for elevated air pollution levels. The information is distributed to the news media and posted on MassDEP's website at [www.mass.gov/air](http://www.mass.gov/air).

MassDEP's website also provides live data from each of the monitoring sites, explanations of the health effects of pollution, information about the National Ambient Air Quality Standards (NAAQS), and historical air quality monitoring data and air quality trends.

- **Verify compliance with National Ambient Air Quality Standards (NAAQS).** EPA specifies the minimum number of monitors that must be located in Massachusetts to demonstrate whether or not the state is in attainment of each of the criteria pollutants. Currently Massachusetts is in attainment of all of the NAAQS except for ozone.
- **Assess the effectiveness of current air pollution control regulations and initiatives / support development of policies and regulations aimed at reducing air pollution.** MassDEP must develop and implement State Implementation Plans (SIPs) that specify the air pollution controls and strategies that will be adopted to attain and maintain the NAAQS and meet Regional Haze requirements. Massachusetts developed SIPs to come into attainment with the CO, Particulate and ozone NAAQS. Massachusetts will likely be in nonattainment of the new ozone standard expected in December 2010 and will need to develop a SIP for meeting that standard. Should Massachusetts be in nonattainment for the new the recently revised SO<sub>2</sub> and NO<sub>2</sub> standards, or a lower PM<sub>2.5</sub> standard expected in 2011, MassDEP will have to develop SIPs to control these pollutants.
- **Ambient monitoring data are used in conjunction with modeling to characterize the extent of air pollution problems, including transport into and out of the state, as well as to evaluate the impacts of alternative control strategies.** Because Massachusetts is a member of three interstate regional organizations charged with coordinating the development of air pollution control plans - the Ozone Transport Commission (OTC), Northeast States for Coordinated Air Use Management (NESCAUM), and the Mid-Atlantic/Northeast Visibility Union (MANE-VU) – MassDEP's data are integral to regional air pollution control planning efforts. The PAMS sites are particularly important for the OTC's work of assessing ozone and its control. Exhibit 2-5 below shows the membership of these groups.

Exhibit 2-5  
Interstate Groups Using MassDEP Ambient Air Quality Data

State or Organization	OTC	NESCAUM	MANE-VU
Connecticut	x	x	x
Delaware	x		x
District of Columbia	x		x
Maine	x	x	x
Maryland	x		x
Massachusetts	x	x	x
New Hampshire	x	x	x
New Jersey	x	x	x
New York	x	x	x
Pennsylvania	x		x
Rhode Island	x	x	x
Vermont	x	x	
Virginia	x		
Environmental Protection Agency	x		x
National Park Service			x
Penobscot Indian Nation			x
St Regis Mohawk Tribe			x
U.S. Fish and Wildlife Service			x
U.S. Forest Service			x

- Site-specific permitting.** MassDEP staff and consultants use ambient air quality and meteorological monitoring data to make site-specific permitting decisions that ensure that emissions from new or modified facilities do not cause or contribute to violations of NAAQS or consume Prevention of Significant Deterioration increments. In addition, meteorological and toxic chemical monitoring information is used in conjunction with models to estimate whether or not emissions are likely to result in exceedances of MassDEP's Ambient Air Limits for toxic pollutants.
- Research.** Environmental and medical academics, the Massachusetts Department of Public Health, the World Health Organization, conservation groups, environmental advocates, and consultants use ambient air monitoring data to evaluate the public health and environmental impacts of air pollution and to develop and "ground truth" ambient air quality models. Air quality data also are used to better characterize the behavior of contaminants in the atmosphere.
- To provide data from Massachusetts sites for nation-wide EPA sponsored programs.** Two examples of nationwide initiatives are NATTS (National Air Toxics Trends Site) and PM<sub>2.5</sub> Speciation monitoring networks, which track spatial and temporal concentration trends of specific air pollutants throughout the U.S.

### III. MASSACHUSETTS POPULATION

The U.S. Census Bureau estimates that as of 2009, Massachusetts had just over 6.5 million inhabitants in 14 counties.

#### Population in U.S. Census Bureau Core Based Statistical Areas (CBSA)

As shown in the Exhibit 3-1, U.S. Census Bureau data show that the vast majority of Massachusetts inhabitants live in Core Based Statistical Areas (CBSAs). In 2008 (the most recent date for which the CBSA data are available), of the total population of 6.5 million people, approximately 6.4 million people lived in one of the state's six CBSAs.

EXHIBIT 3-1

METROPOLITAN AREAS	TOTAL 2008 POPULATION OF CBSA (INCLUDING NON MA RESIDENTS)	TOTAL 2008 POPULATION OF MA COUNTIES INCLUDED IN MULTI STATE CBSAS	# PERSONS UNDER 20 YEARS OF AGE IN CBSA	# PERSONS UNDER 20 IN THE MA COUNTIES INCLUDED IN MULTI STATE CBSA	% PERSONS UNDER 20 IN MA COUNTIES INCLUDED IN MULTI STATE CBSA
Barnstable Town, MA Metro Area	221,049		43,546.653		20%
Boston-Cambridge-Quincy, MA-NH Metro Area	4,522,858	4,103,594	1,135,237.4	1,030,038	25%
Pittsfield, MA Metro Area	129,395		28,466.9		22%
Providence-New Bedford-Fall River, RI-MA Metro Area	1,596,611	545,823	402,345.97	138,987	25%
Springfield, MA Metro Area	687,558	615,823	177,389.96	161,797	26%
Worcester, MA Metro Area	783,806		209,276.2		27%
County	2008 Population				
Barnstable	221,049		43,530		20%
Berkshire	129,395		28,499		22%
Bristol	545,823		138,987		25%
Essex	736,457		191,954		26%
Franklin	71,735		15,272		21%
Hampden	460,840		124,926		27%
Hampshire	154,983		36,871		24%
Middlesex	1,482,478		363,086		24%
Norfolk	659,909		165,837		25%
Plymouth	492,066		130,451		27%
Suffolk	732,684		178,710		24%
Worcester	783,806		210,173		27%
TOTAL	6,471,225		1,628,296		25%

### III. A Population Growth

As shown in Exhibit 3-2, the U.S. Census Bureau estimates that Massachusetts' population has grown by approximately 4% percent between 2000 and 2009. This growth has been fairly uniform across the state, and no county's proportional share of the total statewide population changed by more than + or – 1% between 2000 and 2009. Only Plymouth and Barnstable Counties (italicized and bolded in Exhibit 3-2) changed their proportional share.

Exhibit 3-2  
Massachusetts Population 2000 - 2009

COUNTY	POP 2000	POP 2009	% CHANGE	ABSOLUTE CHANGE	% OF STATE 2000	%Of State 2009
<b><i>Barnstable</i></b>	<b>222,234</b>	<b>221,151</b>	<b>-0.49%</b>	<b>-1,083</b>	<b>4%</b>	<b>3%</b>
Berkshire	134,953	129,288	-4.20%	-5,665	2%	2%
Bristol	534,682	547,433	2.38%	12,751	8%	8%
Dukes	14,987	15,974	6.59%	987	0%	0%
Essex	723,421	742,758	2.67%	19,337	11%	11%
Franklin	71,535	71,778	0.34%	243	1%	1%
Hamden	456,226	471,081	3.26%	14,855	7%	7%
Hampshire	152,255	156,044	2.49%	3,789	2%	2%
Middlesex	1,466,396	1,505,006	2.63%	38,610	23%	23%
Nantucket	9,520	11,322	18.93%	1,802	0%	0%
Norfolk	650,306	666,303	2.46%	15,997	10%	10%
<b><i>Plymouth</i></b>	<b>472,822</b>	<b>498,344</b>	<b>5.40%</b>	<b>25,522</b>	<b>7%</b>	<b>8%</b>
Suffolk	689,809	753,580	9.24%	63,771	11%	11%
Worcester	749,973	803,701	7.16%	53,728	12%	12%
MA TOTAL	6,349,119	6,593,763	3.85%			

Population growth also has been uniform in each of the “airsheds” served by the different monitors. MassDEP used EPA’s Population Served Network Assessment Tool to calculate population growth between 2000 and 2008 in each of the “voronoi polygons” that describe the area covered by a given monitor. A voronoi polygon is the shape formed by the line connecting the points equidistant between a given monitor and each of the other monitors closest to it. The area within the shape created by the lines surrounding the monitor is geographically closer to that monitor than to any other monitor in the network and is therefore considered to be in its coverage area. Note that this is a mathematical construct. Geographic features such as hills or valleys or manmade features such as pollution sources or the development pattern of an area could affect whether the air quality in one area is best characterized by the monitor that is closest to it “as the crow flies.”

The results presented in Exhibit 3-3 show that each polygon’s proportion of the overall state population did not change by more than 1% between 1990 and 2008 (those that did change are italicized and bolded).

Exhibit 3-3  
Change in Population and Population Proportion in Voronoi Polygon for each monitor: 2000 to 2008

Monitor Type	City	Address	Site Id	2000 POP	2008 POP	%Growth 2000 To 2008	% Pop Share 2000	% 2008 Pop Share
PM <sub>2.5</sub>								
BAM	Fall River	659 Globe St	250051004	1,115,396	1,126,176	1%	15%	15%
BAM	Lynn	390 Parkland	250092006	621,343	632,006	2%	9%	9%
BAM	Haverhill	Consentino School	250095005	933,155	963,404	3%	13%	13%
BAM	Springfield	Liberty P-Lot	250130016	689,305	704,791	2%	10%	10%
BAM	Ware	Quabbin Summit	250154002	328,587	335,928	2%	5%	5%
BAM	Milton	Blue Hill	250213003	1,033,412	1,058,159	2%	14%	14%
BAM	Boston	Harrison Av	250250042	886,622	919,216	4%	12%	12%
BAM	Boston	174 North St	250250043	652,215	670,173	3%	9%	9%
BAM	Worcester	Summer St	250270023	959,271	995,788	4%	13%	13%
FRM	Pittsfield	78 Center St	250035001	242,130	235,333	-3%	3%	3%
FRM	Fall River	659 Globe St	250051004	1,022,655	1,031,374	1%	14%	14%
FRM	Lynn	390 Parkland	250092006	537,074	546,753	2%	7%	7%
FRM	Haverhill	Consentino School	250095005	250,578	260,289	4%	3%	3%
FRM	Lawrence	Shattuck St	250096001	771,448	793,193	3%	10%	10%
FRM	Chicopee	Anderson Rd	250130008	403,640	409,580	1%	5%	5%
FRM	Springfield	Liberty P-Lot	250130016	269,760	279,012	3%	4%	4%
FRM	Springfield	1860 Main St- Springfield Republican	250132009	225,302	228,783	2%	3%	3%
FRM	Brockton	Commercial St	250230004	743,271	762,554	3%	10%	10%
FRM	Boston	Kenmore Sq	250250002	776,122	792,029	2%	10%	10%
FRM	Boston	One City Sq	250250027	396,344	405,262	2%	5%	5%
FRM	Boston	Harrison Av	250250042	609,565	635,627	4%	8%	8%
FRM	Boston	174 North St	250250043	114,057	120,906	6%	2%	2%
FRM	Worcester	Washington St	250270016	448,828	467,110	4%	6%	6%
FRM	Worcester	Summer St	250270023	631,664	654,572	4%	8%	9%
NO <sub>2</sub>	Lynn	390 Parkland	250092006	607,594	619,006	2%	9%	9%
NO <sub>2</sub>	Newbury	Sunset Blvd	250094004	95,892	98,199	2%	1%	1%
NO <sub>2</sub>	Haverhill	Consentino School	250095005	1,048,115	1,087,233	4%	16%	16%
NO <sub>2</sub>	Chicopee	Anderson Rd	250130008	198,265	200,838	1%	3%	3%
NO <sub>2</sub>	Springfield	Liberty P-Lot	250130016	315,718	320,919	2%	5%	5%
NO <sub>2</sub>	Ware	Quabbin Summit	250154002	236,281	243,211	3%	4%	4%
NO <sub>2</sub>	Milton	Blue Hill	250213003	1,566,767	1,593,722	2%	24%	23%
<b>NO<sub>2</sub></b>	<b>Boston</b>	<b>Kenmore Sq</b>	<b>250250002</b>	<b>1,095,886</b>	<b>1,120,995</b>	<b>2%</b>	<b>17%</b>	<b>16%</b>
NO <sub>2</sub>	Boston	Long Island	250250041	187,687	192,924	3%	3%	3%
NO <sub>2</sub>	Boston	Harrison Av	250250042	326,897	347,213	6%	5%	5%
NO <sub>2</sub>	Worcester	Summer St	250270023	937,544	971,944	4%	14%	14%
NO <sub>y</sub>	Newbury	Sunset Blvd	250094004	1,235,806	1,276,332	3%	25%	25%
NO <sub>y</sub>	Ware	Quabbin Summit	250154002	587,611	612,144	4%	12%	12%
<b>NO<sub>y</sub></b>	<b>Milton</b>	<b>Blue Hill Obs</b>	<b>250213003</b>	<b>3,051,631</b>	<b>3,134,516</b>	<b>3%</b>	<b>63%</b>	<b>62%</b>
Ozone	Adams	Mt Greylock Summit	250010002	113,891	113,284	-1%	2%	2%
Ozone	Truro	Fox Bottom Area	250010002	113,891	113,284	-1%	2%	2%

Monitor Type	City	Address	Site Id	2000 POP	2008 POP	%Growth 2000 To 2008	% Pop Share 2000	% 2008 Pop Share
Ozone	Fairhaven	Leroy Wood Sch	250051002	720,839	731,369	1%	10%	10%
Ozone	Lynn	390 Parkland	250092006	674,996	687,615	2%	10%	10%
Ozone	Newbury	Sunset Blvd	250094004	126,963	129,831	2%	2%	2%
Ozone	Haverhill	Consentino School	250095005	932,683	969,145	4%	13%	14%
<b>Ozone</b>	<b>Chicopee</b>	<b>Anderson Rd Afb</b>	<b>250130008</b>	<b>660,425</b>	<b>673,892</b>	<b>2%</b>	<b>10%</b>	<b>9%</b>
Ozone	North Amherst	N Pleasant St	250150103	237,318	242,289	2%	3%	3%
Ozone	Ware	Quabbin Summit	250154002	62,698	64,184	2%	1%	1%
Ozone	Stow	Us Military Res	250171102	620,779	634,456	2%	9%	9%
Ozone	Milton	Blue Hill Obs	250213003	786,624	807,168	3%	11%	11%
Ozone	Boston	Long Island	250250041	274,048	282,612	3%	4%	4%
Ozone	Boston	Harrison Av	250250042	1,168,054	1,210,047	4%	17%	17%
<b>Ozone</b>	<b>Worcester</b>	<b>Worc Airport</b>	<b>250270015</b>	<b>446,430</b>	<b>466,193</b>	<b>4%</b>	<b>6%</b>	<b>7%</b>
SO <sub>2</sub>	Fall River	659 Globe St	250051004	1,089,051	1,101,396	1%	22%	22%
<b>SO<sub>2</sub></b>	<b>Springfield</b>	<b>Liberty P-Lot</b>	<b>250130016</b>	<b>564,721</b>	<b>575,881</b>	<b>2%</b>	<b>12%</b>	<b>11%</b>
SO <sub>2</sub>	Ware	Quabbin Summit	250154002	189,440	193,526	2%	4%	4%
SO <sub>2</sub>	Boston	Kenmore Sq	250250002	990,812	1,014,626	2%	20%	20%
<b>SO<sub>2</sub></b>	<b>Boston</b>	<b>Harrison Av</b>	<b>250250042</b>	<b>1,142,493</b>	<b>1,184,021</b>	<b>4%</b>	<b>23%</b>	<b>24%</b>
SO <sub>2</sub>	Worcester	Summer St	250270023	929,703	963,777	4%	19%	19%
VOC	Lynn	390 Parkland	250092006	1,510,162	1,539,896	2%	25%	25%
<b>VOC</b>	<b>Newbury</b>	<b>Sunset Blvd</b>	<b>250094004</b>	<b>617,830</b>	<b>645,571</b>	<b>4%</b>	<b>10%</b>	<b>11%</b>
<b>VOC</b>	<b>Chicopee</b>	<b>Anderson Rd Afb</b>	<b>250130008</b>	<b>328,128</b>	<b>331,939</b>	<b>1%</b>	<b>6%</b>	<b>5%</b>
VOC	Ware	Quabbin Summit	250154002	773,081	803,975	4%	13%	13%
VOC	Milton	Blue Hill Obs	250213003	1,916,631	1,961,857	2%	32%	32%
VOC	Boston	Long Island	250250041	806,284	839,078	4%	14%	14%

Source EPA Network Assessment Area Served Tool

Because the population distribution has remained the same over the past ten years and no significant shifts are expected in the future, MassDEP does not believe that it needs to change its network design on the basis of population distribution.

### III. B Sensitive Populations

As shown in Exhibit 3-1 above, in 2008 about 25% of the state's residents were under 20 years old. Children are spread fairly uniformly throughout the state, comprising approximately 25% of the population of the four largest metropolitan areas. This distribution holds true in all of the metropolitan areas except the Barnstable County Metropolitan Statistical Area (MSA) on Cape Cod and the Pittsfield MSA in western Massachusetts where only 20% and 22%, respectively, of the population is under age 20. On a county basis, children in Barnstable, Franklin, and Berkshire counties represent between 20% and 22% of the population. It is important to note that while large in land area, these three counties contain only about 6% of the total population of Massachusetts, or approximately 423,000 people. Only the island counties of Dukes and Nantucket, with a combined population of 30,000, have fewer inhabitants.

As shown in Exhibit 3-4, the distribution of individuals with compromised health is less uniform than the distribution of children.

Exhibit 3-4  
Incidence of Air Pollution-Related Disease in MA Counties  
(Higher rates of a particular condition have been bolded and italicized).

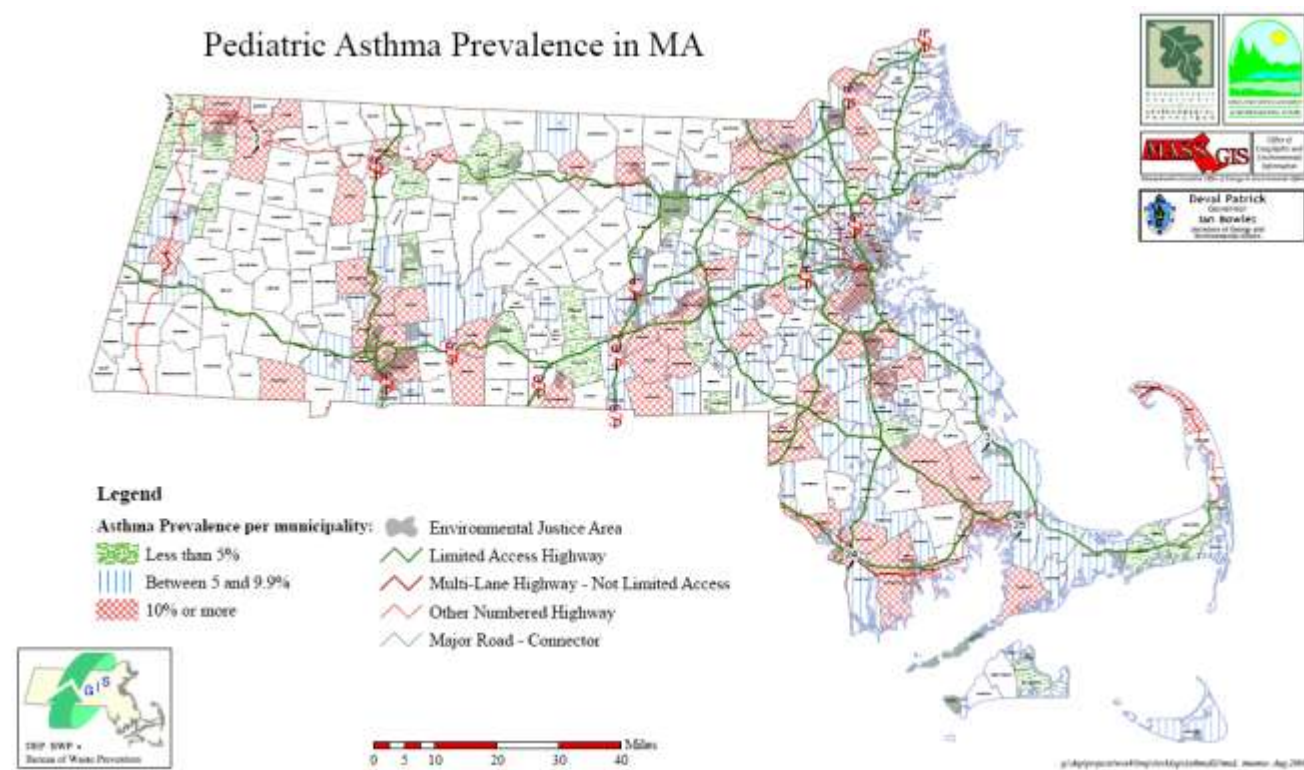
COUNTY	LUNG/BRONCHUS CANCER INCIDENCE PER 100,000 PEOPLE (2006)	ASTHMA RELATED HOSPITALIZATIONS PER 100,000 PEOPLE (2007)	CIRCULATORY DISEASE RELATED HOSPITALIZATIONS PER 100,000 PEOPLE (2008)	RESPIRATORY DISEASE RELATED HOSPITALIZATIONS PER 100,000 PEOPLE (2008)
<b>Barnstable</b>	<b>126.71</b>	<b>1,490.04</b>	<b>1,399.53</b>	1,152.74
<b>Berkshire</b>	<b>124.28</b>	1,290.5	<b>1,434.48</b>	<b>1,367.79</b>
Bristol	83.8	<b>1,718.97</b>	1,242.99	<b>1,382.11</b>
<b>Dukes</b>	76.9	<b>1,320.09</b>	1,249.6	813.84
<b>Essex</b>	79.95	<b>1,362.36</b>	1,260.42	1,160.75
Franklin	70.43	744.32	987.36	943.17
<b>Hampden</b>	79.06	<b>1,320.44</b>	1,216.31	1,122.04
Hampshire	59.75	872.19	959.21	848.81
Middlesex	69.12	908.22	1,107.17	958.35
<b>Nantucket</b>	59.44	<b>2,129.87</b>	1,059.98	683.54
Norfolk	84.85	727.98	<b>1,318.72</b>	1,096.47
Plymouth	85.6	723.35	<b>1,402.09</b>	<b>1,250.59</b>
<b>Suffolk</b>	69.14	<b>1,692.97</b>	1,117.1	<b>1,235.54</b>
<b>Worcester</b>	69.55	<b>1,423.71</b>	1,184.1	1,115.18
<b>Massachusetts Total</b>	<b>78</b>	<b>1,201.55</b>	<b>1,200.41</b>	<b>1,115.18</b>
Source: Massachusetts Department of Public Health MassCHIP				

Exhibit 3-4 shows that:

- The incidence of lung and bronchus cancer per hundred thousand people is substantially higher in Barnstable and Berkshire counties than in the rest of the state;
- Hospitalization rates for circulatory-related diseases are higher than the state wide rate of 1,200 per 100,000 in four counties: Barnstable, Berkshire, Norfolk and Plymouth. The hospitalization rate is lower in Franklin and Hampshire counties.
- Hospitalization rates for respiratory diseases are higher than the statewide rate of 1,115 per 100,000 people in four counties: Berkshire, Bristol, Plymouth and Suffolk. These rates are lower in Nantucket, Dukes, Hampshire, Franklin and Middlesex.
- Asthma-related hospitalizations per hundred thousand people are higher than the statewide average in Nantucket, Bristol, Suffolk, Barnstable, Worcester, Essex, Hampden, and Dukes in descending order. They are substantially lower in Plymouth, Norfolk, Franklin, and Middlesex. Only Berkshire, at 1,290 per 100,000, is close to the statewide average of 1,201 per 100,000

A closer look at pediatric asthma prevalence by town, as shown in Exhibit 3-5, indicates that the rate varies from town to town within a county. The areas with higher rates of pediatric asthma have good monitoring coverage with the exception of a stretch along route 2 in northern Worcester and Franklin Counties and Cape Cod, which lack PM<sub>2.5</sub> monitors.

Exhibit 3-5



## Environmental Justice Populations

As shown in Exhibit 3-5, Massachusetts has several environmental justice communities comprised of high minority ( $\geq 25\%$ ), non-English speaking ( $\leq 75\%$ ), low-income (median income  $< 65\%$  of the statewide median income), and foreign-born populations ( $\geq 25\%$ ). With the exception of one site in Franklin County and some small areas on the Cape and Islands, the environmental justice areas are served by air monitors.

### III. C The Effect of Current Massachusetts Population Characteristics On Monitoring Network Design

There have been no major population shifts in Massachusetts in the past ten years. There are no large pockets of sensitive populations that are underserved by air monitoring, with the possible exception of Cape Cod and the northern Worcester County/ Franklin County area. As a result, MassDEP does not recommend changes in the air monitoring network design based on the demographic characteristics of Massachusetts.

## IV. AIR QUALITY SUMMARY

### IV. A Ambient Air Quality Summary

EPA has established health-based National Ambient Air Quality Standards (NAAQS) for six pollutants: ozone (O<sub>3</sub>); nitrogen dioxide (NO<sub>2</sub>); particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>); carbon monoxide (CO); sulfur dioxide (SO<sub>2</sub>); and lead (Pb). EPA has classified Massachusetts as “unclassified” or “attainment” for all of the NAAQS except the 1997 ozone standard, for which Massachusetts is classified as “nonattainment.” As shown by Exhibit 4-1, Massachusetts has been in attainment of most NAAQS since the mid 1980s. All areas in Massachusetts attained the CO standard in the early 2000s. Ozone is the only pollutant for which Massachusetts is still nonattainment.

Exhibit 4-1  
NAAQS Attainment Status in Massachusetts

Pollutant	Primary Standards		Status of NAAQS and Major Risk Issues in Agency's Network	Extent of NAAQS Violations (list areas violating NAAQS)	# of Days on which Violations of the NAAQS Occurred	Contribution to Downwind Violations?
	Level	Averaging Time				
Carbon Monoxide	9 ppm (10 mg/m <sup>3</sup> ) 35 ppm (40 mg/m <sup>3</sup> )	8-hour 1-hour	EPA designated the last areas in MA as attainment for CO in February 2002. CO levels have continued to drop since this time See Exhibits in Section V.C CO			
Lead	0.15 µg/m <sup>3</sup> 1.5 µg/m <sup>3</sup>	Rolling 3-Month Average Quarterly Average	MA monitored data has been below the new standard since before 1985 See Exhibits in Section V.D Pb			
Nitrogen Dioxide	53 ppb 100 ppb	Annual Arithmetic Average 1-hour	MA has been well below the standard since before 1985 See Exhibits in Section V.F NO <sub>2</sub> MA anticipates being in attainment of this new standard			
Particulate Matter (PM <sub>10</sub> )	150 µg/m <sup>3</sup>	24-hour	Massachusetts is in attainment of both the PM <sub>10</sub> and PM <sub>2.5</sub> standards See Exhibits in Section V.A PM			
Particulate Matter (PM <sub>2.5</sub> )	15.0 µg/m <sup>3</sup> 35 µg/m <sup>3</sup>	Annual Arithmetic Average 24-hour				
Ozone	0.075 ppm (2008 std)	8-hour	MA does not attain this standard. For more detail see Exhibits in Section V.B Ozone	Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA Ware MA Chicopee MA Amherst MA	See Exhibit 5B-3 in Section V.B Ozone	NH and ME also have recorded exceedances See Exhibit 5B-7 in Section V.B Ozone
	0.08 ppm (1997 std)	8-hour	In 2008 MassDEP submitted an attainment demonstration for the 1997 standard. Monitored data for 2007-2009 indicate that no monitor violated the 1997 standard during this period.			
	0.12 ppm	1-hour	This standard has been revoked. While MA had many exceedances during the early 2000s, they have been rare for the past few years			
Sulfur Dioxide	0.03 ppm 0.14 ppm	Annual Arithmetic Average 24-hour	MA has been well below the standard since before 1985 See Exhibits in Section V.E SO <sub>2</sub>			
	75 ppb	1-hour	MA anticipates being in attainment of this new standard			

Massachusetts has two ozone nonattainment areas. The western Massachusetts nonattainment area encompasses Hampden, Hampshire, Franklin, and Berkshire counties. The eastern Massachusetts nonattainment area encompasses the remainder of the state. Both areas are classified as moderate nonattainment under the 1997 ozone standard. Due to transport,

Massachusetts is affected by upwind emissions of ozone and ozone precursors. Similarly, emissions in Massachusetts contribute to air pollution in nearby states.

Ozone levels have steadily declined since the mid 1980s (see the Exhibits in Section V.B Ozone). MassDEP submitted to EPA a demonstration of attainment for the 1997 8-hour ozone standard and Massachusetts rarely experiences exceedances of the now revoked 1-hour ozone standard. For the 2007-2009 period, ozone concentrations in Massachusetts did not exceed the 1997 8-hour ozone standard of 0.08 ppm. Massachusetts does not attain the 0.075 ppm 8-hour ozone standard promulgated in 2008, which is being reconsidered by EPA, and is unlikely to attain the revised and more stringent ozone standard expected to be adopted by EPA in December 2010.

## **IV. B Emissions Inventory Summary**

Improvements in air quality in Massachusetts can be directly correlated to significant reductions in air pollution emissions since 1990. Based on EPA's published National Emission Inventory data for 1990 and 2005 (the most recent published inventory), emissions of VOC, NO<sub>x</sub>, CO, SO<sub>2</sub>, and PM<sub>2.5</sub> have decreased between 29% and 66%, depending on the pollutant.

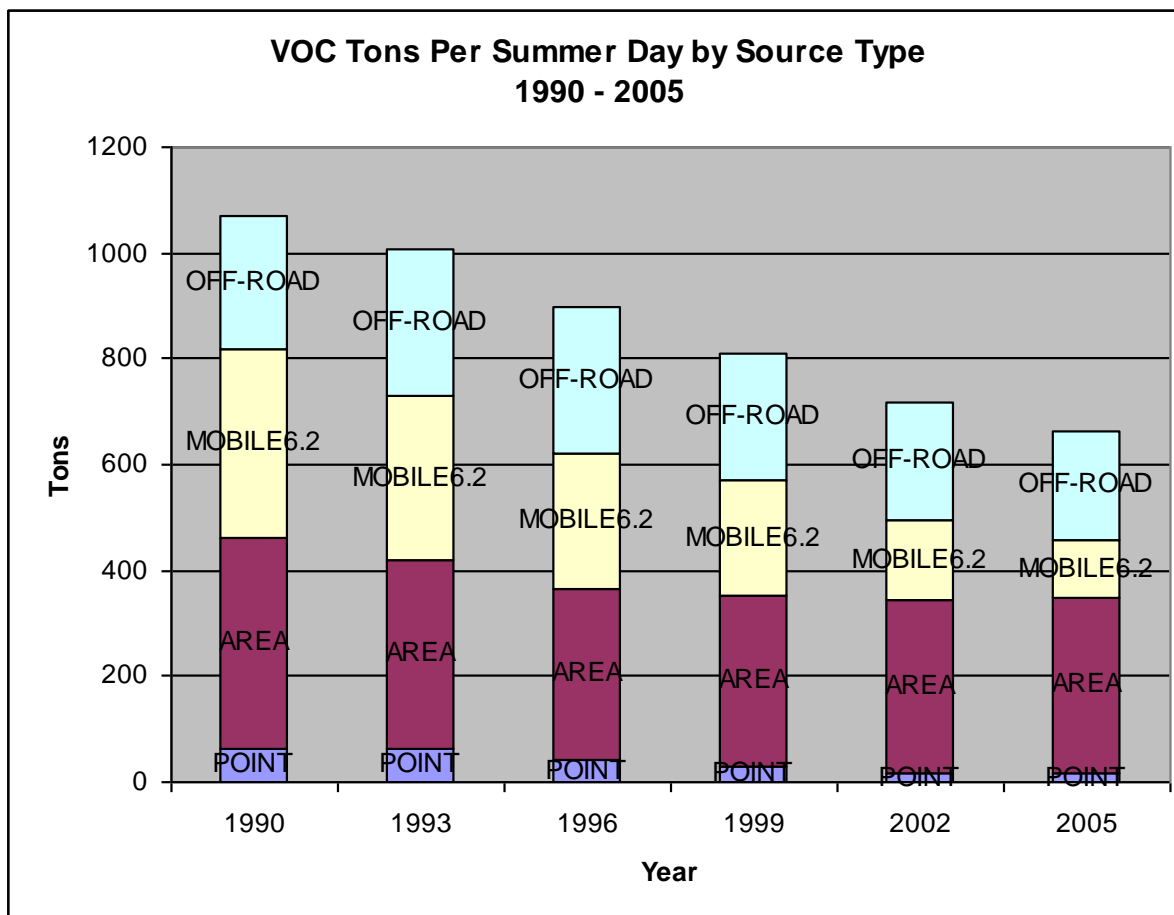
Emissions reductions have been due to several factors, including better controls on stationary source, area source, and motor vehicle emissions and a decline in manufacturing activity in the state.

### **IV. B-1 VOC**

Total VOC emissions were reduced by 406 tons per summer day (TPSD), or 38%, from 1990 to 2005, with 245 tons of those reductions attributable to on-road mobile sources. The on-road mobile source emission reductions for this period, in spite of increased vehicle miles traveled, are due to the ongoing numerous programs to reduce emissions from motor vehicles, including the Federal Motor Vehicle Control Program (FMVCP), Massachusetts Low Emission Vehicle (LEV) program, Massachusetts Enhanced Inspection and Maintenance (MA I/M) program, Stage II Vapor Recovery for gasoline stations, and reformulated gasoline (RFG).

As shown in Exhibit 4-2, the reductions have come from all four sectors: off-road vehicle, on-road vehicle, area, and point sources. The largest share has come from on-road vehicles.

Exhibit 4-2



MassDEP has recently adopted regulations and has plans to adopt additional regulations that will further reduce VOC emissions. MassDEP has promulgated new standards for the following emissions source categories: architectural, industrial and maintenance (AIM) coatings, consumer products, solvent metal degreasing, and gasoline vapor recovery (Stage II vent caps). MassDEP intends to propose and adopt new regulations to control emissions from asphalt paving and adhesives and sealants within the next 12 months to obtain additional reductions. Because these VOC controls have been or are being adopted by many other Ozone Transport Commission states upwind of Massachusetts, MassDEP expects pollution transported into the state to be reduced as well.

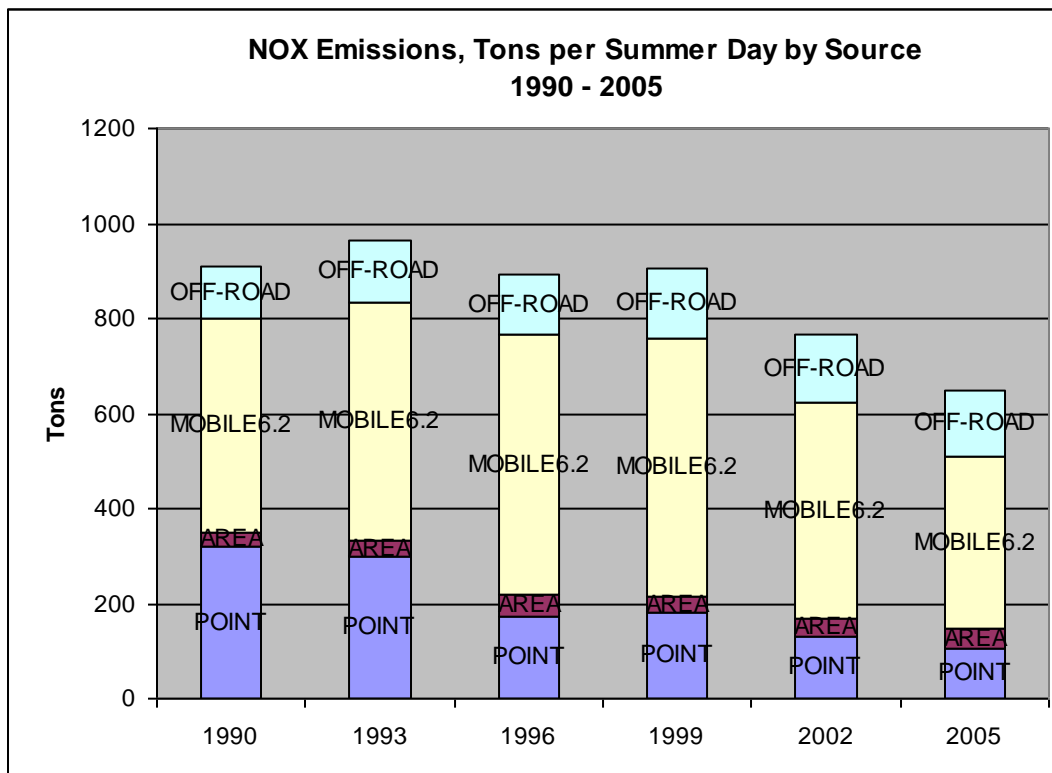
MassDEP also regularly amends its low emission vehicle (LEV) program to stay current with program requirements and to continue to accrue associated emissions reduction benefits. Additionally, EPA has adopted national control measures for on-road and off-road engines and fuels that will continue to significantly reduce emissions from these categories subsequent to 2005. Finally, MassDEP is participating in the ongoing OTC regional ozone attainment planning process that will result in recommendations to the states to adopt additional ozone control measures. MassDEP will adopt the recommended measures as needed and appropriate for ozone attainment.

#### IV. B-2 NO<sub>x</sub>

Total NO<sub>x</sub> emissions decreased by 262 TPSD, or 29%, from 1990 to 2005. Point source reductions of 213 TPSD are attributable to the Reasonably Available Control Technology (RACT) program and reductions in power plant emissions and plant closures. Although overall NO<sub>x</sub> emissions increased slightly by 2 TPSD from on-road mobile sources from 1990 to 2002, the reduction from 1999 to 2005 was 20%, reversing the trend of increasing emissions for this category from 1990-1999. This reduction is attributable to the MA I/M and LEV programs, and more reductions are expected as older, higher emitting cars are replaced with cleaner vehicles. Although off-road NO<sub>x</sub> emissions increased by approximately 28% during this period, EPA regulation of off-road vehicles and Massachusetts diesel control programs are expected to reduce NO<sub>x</sub> emissions from this category subsequent to 2005.

As shown in Exhibit 4-3, while off-road and area source emissions have increased slightly since 1990, on road vehicles and point source emissions have declined substantially. Continued efforts to control ozone should result in further reductions in NO<sub>2</sub> and NO<sub>x</sub> emissions.

Exhibit 4-3

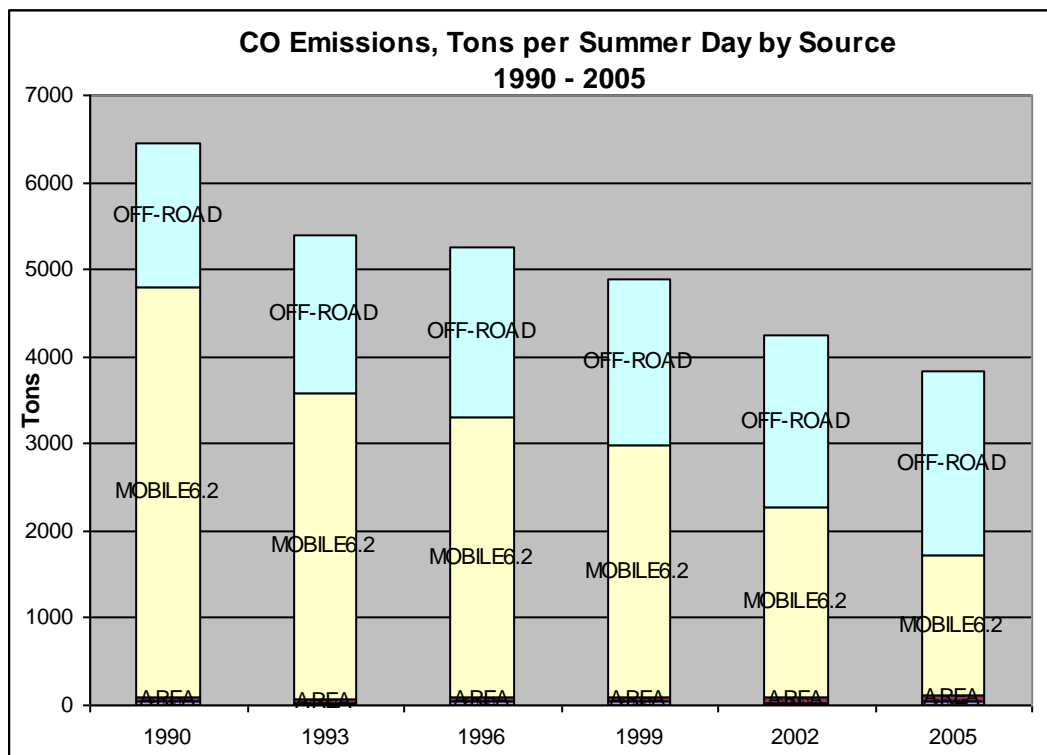


#### IV. B-3 CO

Total CO emissions decreased by 2,624 TPSD, or 41%, from 1990 to 2005. Despite slight increases in emissions from point, area and off-road categories, the overall reduction is attributable to an estimated 3,093 TPSD (66%) reduction in on-road mobile emissions for this period. Future reductions from off-road engines are expected as federal programs to control emissions from these sources are implemented.

As shown in Exhibit 4-4, CO emissions are driven almost entirely by on- and off-road vehicles. While mobile source emissions have decreased dramatically between 1990 and 2005, off-road emissions have increased.

Exhibit 4-4

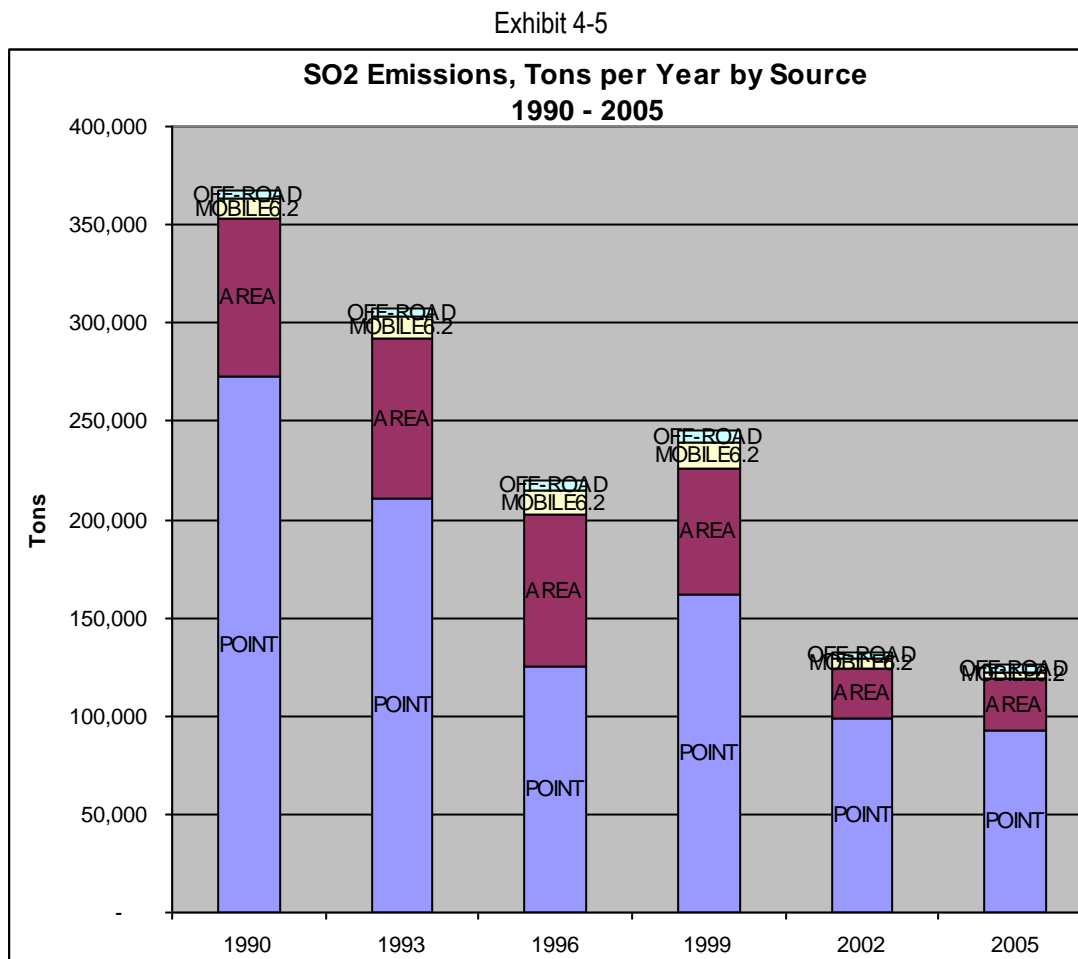


#### IV. B-4 SO<sub>2</sub>

Total SO<sub>2</sub> emissions decreased by 241,388 tons per year (TPY), or 66%, from 1990 to 2005. Point sources that combust fuel, mainly power plants, accounted for a reduction of 180,270 TPY. The Massachusetts State Acid Rain Program regulation, 310 CMR 7.21, requires that MassDEP report statewide SO<sub>2</sub> emissions annually to determine whether a state statutory cap and trigger level of SO<sub>2</sub> emissions are exceeded. A comparison of the annual emission levels and the state statutory cap and trigger levels since 1979 reveals that 2005 emissions are less than half of the 310 CMR 7.21 statutory cap and trigger levels. This is the result of the federal acid rain control

program, as well as MassDEP's SO<sub>2</sub> emissions reduction programs. Ongoing efforts to further control power plants and to control regional haze should result in even further SO<sub>2</sub> reductions.

As shown in Exhibit 4-5, SO<sub>2</sub> emissions are driven almost entirely by point and areas source emissions. Both have declined by more than half since 1990.



#### IV. B-5 PM<sub>2.5</sub>

EPA estimates that PM<sub>2.5</sub> emissions declined by 31% between 1990 and 2005 (based on extrapolations from historic TSP and PM<sub>10</sub> data). PM<sub>2.5</sub> was first inventoried in the 2002 baseline inventory that was finalized in 2007. Increases in biomass burning as area sources or as stationary sources could drive localized PM<sub>2.5</sub> levels upward in future years.

#### IV. B-6 DISTRIBUTION OF EMISSION REDUCTIONS

As shown in Exhibit 4-6, except for Nantucket and Dukes (Martha's Vineyard) Counties, emissions have declined fairly uniformly across the state.

Exhibit 4-6  
Emissions Reduction by Pollutant and County

COUNTY	POLLUTANT	1990	2002	2005	% CHANGE 1990 - 2005
Barnstable	CO	213,453	201,372	210,206	-2%
	NO <sub>x</sub>	18,652	23,181	12,723	-32%
	PM <sub>2.5</sub>	3,603	4,074	3,346	-7%
	SO <sub>2</sub>	63,372	28,445	28,276	-55%
	VOC	19,681	21,209	15,975	-19%
Berkshire	CO	98,671	54,441	27,745	-72%
	NO <sub>x</sub>	10,665	8,349	6,105	-43%
	PM <sub>2.5</sub>	4,315	2,414	2,393	-45%
	SO <sub>2</sub>	10,629	1,962	2,521	-76%
	VOC	14,161	11,139	7,869	-44%
Bristol	CO	447,624	188,978	160,148	-64%
	NO <sub>x</sub>	62,226	28,237	23,756	-62%
	PM <sub>2.5</sub>	5,223	5,874	5,843	12%
	SO <sub>2</sub>	103,652	48,701	41,578	-60%
	VOC	32,154	24,870	19,159	-40%
Dukes	CO	25,104	24,053	20,948	-17%
	NO <sub>x</sub>	696	4,291	2,119	205%
	PM <sub>2.5</sub>	532	895	738	39%
	SO <sub>2</sub>	229	1,557	313	37%
	VOC	4,248	3,398	2,460	-42%
Essex	CO	606,854	264,599	233,286	-62%
	NO <sub>x</sub>	48,276	25,299	21,906	-55%
	PM <sub>2.5</sub>	6,114	3,457	4,525	-26%
	SO <sub>2</sub>	56,349	20,259	17,201	-69%
	VOC	50,166	30,433	26,192	-48%
Franklin	CO	131,409	78,095	53,340	-59%
	NO <sub>x</sub>	6,726	5,950	3,971	-41%
	PM <sub>2.5</sub>	2,914	2,342	2,324	-20%
	SO <sub>2</sub>	2,370	895	1,029	-57%
	VOC	12,687	8,581	30,042	137%
Hampden	CO	403,137	207,516	166,954	-59%
	NO <sub>x</sub>	26,049	19,981	10,861	-58%
	PM <sub>2.5</sub>	4,830	3,940	3,858	-20%
	SO <sub>2</sub>	20,242	9,851	9,710	-52%
	VOC	25,328	20,105	16,192	-36%

COUNTY	POLLUTANT	1990	2002	2005	% CHANGE 1990 - 2005
Hampshire	CO	155,653	87,955	63,832	-59%
	NO <sub>x</sub>	7,683	5,698	4,337	-44%
	PM <sub>2.5</sub>	2,905	2,512	2,498	-14%
	SO <sub>2</sub>	3,248	1,000	1,526	-53%
	VOC	12,788	9,191	6,382	-50%
Middlesex	CO	1,194,565	686,832	581,188	-51%
	NO <sub>x</sub>	62,563	49,016	43,608	-30%
	PM <sub>2.5</sub>	12,491	7,391	7,418	-41%
	SO <sub>2</sub>	36,758	14,068	15,249	-59%
	VOC	87,722	62,071	54,218	-38%
Nantucket	CO	16,927	21,379	15,134	-11%
	NO <sub>x</sub>	2,325	18,760	644	-72%
	PM <sub>2.5</sub>	302	1,899	611	102%
	SO <sub>2</sub>	625	10,541	99	-84%
	VOC	2,612	2,890	1,632	-38%
Norfolk	CO	620,449	430,702	375,218	-40%
	NO <sub>x</sub>	27,280	28,588	25,053	-8%
	PM <sub>2.5</sub>	5,560	3,931	3,899	-30%
	SO <sub>2</sub>	10,548	4,137	4,270	-60%
	VOC	42,215	33,557	27,741	-34%
Plymouth	CO	391,226	193,139	168,608	-57%
	NO <sub>x</sub>	18,899	13,313	11,060	-41%
	PM <sub>2.5</sub>	6,851	4,191	4,147	-39%
	SO <sub>2</sub>	7,606	3,005	2,723	-64%
	VOC	36,613	22,757	16,980	-54%
Suffolk	CO	388,528	202,518	178,554	-54%
	NO <sub>x</sub>	59,772	21,453	18,719	-69%
	PM <sub>2.5</sub>	6,075	1,781	2,403	-60%
	SO <sub>2</sub>	21,869	5,787	5,367	-75%
	VOC	25,017	20,254	18,613	-26%
Worcester	CO	701,631	421,181	366,744	-48%
	NO <sub>x</sub>	37,342	32,895	28,065	-25%
	PM <sub>2.5</sub>	10,254	6,882	7,941	-23%
	SO <sub>2</sub>	14,381	6,159	6,837	-52%
	VOC	52,203	42,911	34,030	-35%

2005 data:

State and County Emission Summaries <http://www.epa.gov/air/emissions/index.htm>

1990 and 2002 data:

Air Data: Access to Air Pollution Data Reports and Maps <http://www.epa.gov/air/data/geosel.html>

## **IV. C      Effect Of Changes in Air Quality Status On Monitoring Network Design**

MassDEP believes that emissions trends in Massachusetts do not suggest a need to change the distribution of monitors throughout the state for the following reasons:

- The decline in emissions has been uniform across the state,
- The number of new major point sources is limited and those that are permitted are well controlled,
- Existing point sources are emitting less,
- The monitoring network is designed to characterize highest concentrations and general background concentrations and population exposures rather than the impacts of individual sources, and
- There has been no change in population and road system distribution across the state and therefore limited change in the distribution of area and mobile source emissions across the state.

MassDEP believes that ozone, PM<sub>2.5</sub>, and the interstate transport of these pollutants and their precursors are the most significant air quality concerns and therefore that it is appropriate to retain the existing emphasis of the monitoring network on ozone and PM<sub>2.5</sub>. However, as discussed in Section V., the new monitoring requirements to demonstrate compliance with the new short-term SO<sub>2</sub> and NO<sub>2</sub> NAAQS will require MassDEP to add monitoring sites for these pollutants.

## **V. POLLUTANT BY POLLUTANT NETWORK STATUS**

Section V summarizes the status of the ambient air quality monitoring for each of the following pollutants:

- V.A Particulate Matter (PM) (including speciation and air toxics)
- V.B Ozone (O<sub>3</sub>) (including PAMS monitoring)
- V.C Carbon Monoxide (CO)
- V.D Lead (Pb)
- V.E Sulfur Dioxide (SO<sub>2</sub>)
- V. F Nitrogen Dioxide (NO<sub>2</sub>) (including NO<sub>x</sub>, other oxides of nitrogen)

The following topics are covered for each of these pollutants:

- Monitor locations/descriptions/purposes
- Coverage Area
- Monitoring Data
- Technological Issues
- Adequacy of the Monitoring Network including, for ozone and PM<sub>2.5</sub>, Correlations, New Sites Analysis, and Removal Bias Data
- Monitoring Gaps

Section V.G assesses the Meteorological Network

Section V.H discusses Quality Assurance and Quality Control activities.

### **V. A Particulate Matter (PM)**

#### **V. A-1 NETWORK DESCRIPTION**

MassDEP operates PM monitors at 19 locations across the Commonwealth. At least one monitor is located in each county except for Middlesex, Franklin, Barnstable, Dukes, and Nantucket. The PM network consists of:

- PM<sub>10</sub>: 6 sites:
  - 5 with low volume samplers,
  - 1 (Boston-Harrison Avenue) with a total of 4 PM<sub>10</sub> samplers: 2 collocated high volume samplers and 2 collocated low-volume samplers. The high-volume samples are analyzed for toxic elements as part of the National Air Toxics Trends (NATTS) air monitoring program and gravimetrically measured for comparison with the low-volume PM<sub>10</sub> results.
- PM<sub>2.5</sub>: 18 Total Sites including
  - 15 Federal Reference Method (FRM) PM<sub>2.5</sub> sampling sites. 3 sites (Brockton, Chicopee and Boston-North Street) have two collocated samplers. Boston North-Street runs on a daily sampling schedule. All of the others sample on a 1-in-3 day

schedule. Data from MassDEP's FRM network are currently used to determine if Massachusetts is in attainment of the PM<sub>2.5</sub> National Ambient Air Quality Standard (NAAQS).

- 10 Beta Attenuation Monitor (BAM) sampling sites, 7 of which are collocated with FRM sites and one of which is collocated with an IMPROVE PM<sub>2.5</sub> site that does not have an FRM designation. All BAM sites except for Pittsfield have received Federal Equivalent Method (FEM) designation, which means they could be used to determine if Massachusetts is in attainment of the PM<sub>2.5</sub> NAAQS. BAMs provide the hourly PM<sub>2.5</sub> data that appears on MassDEP's website. Milton-Blue Hill and Pittsfield-South Street are stand alone BAMs, although an FRM sampler is located about a quarter of a mile away at the Pittsfield-Center Street site.
- PM<sub>coarse</sub> (PM<sub>10</sub> – PM<sub>2.5</sub>): 1 site in compliance with NCore requirements at the designated NCore site at Boston-Harrison Avenue beginning in January 2011.
- Speciated PM<sub>2.5</sub>: 2 sites (Boston-Harrison Avenue and Chicopee). The speciated PM<sub>2.5</sub> program is designed to determine some of the chemical constituents (elements, sulfates/nitrates, carbon species) that are contained in PM<sub>2.5</sub>, which can provide information about the sources of the particulate matter.

Massachusetts also has two IMPROVE sampling sites that provide speciated PM<sub>2.5</sub> data. The IMPROVE program measures, at rural locations, parameters that are similar to those measured by the speciation program. The data are used to evaluate the role of fine particulates and their constituents in the degradation of visibility. IMPROVE samplers are located at the following sites:

- Truro - National Sea Shore, operated by the National Park Service
- Ware - Quabbin Reservoir, operated by MassDEP

The Wampanoag Tribe of Gay Head (Aquinnah) on Martha's Vineyard also operates an IMPROVE sampler.

Exhibit 5A-1 lists the particulate matter sites, their location, type of monitoring and purpose of the monitoring.

Exhibit 5A-1  
PM Monitoring Sites

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR MONITOR	DATE ESTABLISHED	MSA/CMSA	PM TYPE
25-025-0002	BOSTON	SUFFOLK	KENMORE SQUARE	Middle	-Highest Concentration -Population Exposure	1/1/1965	Boston CMSA; Boston Metropolitan MSA	PM <sub>10</sub> (LV) PM <sub>2.5</sub> (3-DAY)
25-025-0027	BOSTON	SUFFOLK	ONE CITY SQUARE	Middle	-Highest Concentration -Population Exposure	1/1/1985	Boston CMSA; Boston Metropolitan MSA	PM <sub>10</sub> (LV), PM <sub>2.5</sub> (3-DAY)

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR MONITOR	DATE ESTABLISHED	MSA/CMSA	PM TYPE
25-025-0042	BOSTON	SUFFOLK	HARRISON AVENUE	Neighborhood	Population Exposure	12/15/1998	Boston CMSA; Boston Metropolitan MSA	Pb, PM <sub>10</sub> (LV)(2), PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> (2), BLACK CARBON, SPECIATED SAMPLES
25-025-0043	BOSTON	SUFFOLK	174 NORTH STREET	Middle	-Population Exposure -Maximum Concentration	1/1/2000	Boston CMSA; Boston Metropolitan MSA	PM <sub>2.5</sub> (2) (3-DAY / Daily) BAM <sub>2.5</sub> BLACK CARBON
25-023-0004	BROCKTON	PLYMOUTH	120 COMMERCIAL ST	Neighborhood	Population Exposure	12/15/1998	Boston CMSA; Brockton MSA	PM <sub>2.5</sub> (2) (3-DAY)
25-013-0008	CHICOPEE	HAMPDEN	ANDERSON ROAD	Urban	Population Exposure	1/1/1983	Springfield MSA	PM <sub>2.5</sub> (3-DAY) (2), SPECIATED SAMPLES
25-005-1004	FALL RIVER	BRISTOL	GLOBE STREET	Neighborhood	-Highest Concentration -Population Exposure	2/1/1975	Providence-Pawtucket-Fall River MSA	PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub>
25-009-5005	HAVERHILL	ESSEX	WASHINGTON STREET	PM <sub>2.5</sub> : Neighborhood	Population Exposure	7/19/1994	Boston CMSA; Lawrence MSA	PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub>
25-009-6001	LAWRENCE	ESSEX	WALL EXPERIMENT STATION	Neighborhood	Population Exposure	4/3/1999	Boston CMSA; Lawrence MSA	PM <sub>2.5</sub> (3-DAY)
25-009-2006	LYNN	ESSEX	390 PARKLAND	Urban	Population Exposure	1/1/1992	Boston CMSA; Boston Metropolitan MSA	PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub>
25-021-3003	MILTON	NORFOLK	BLUE HILL	Urban	Maximum Concentration	4/2/2002	Boston CMSA; Boston Metropolitan MSA	BAM <sub>2.5</sub>
25-003-5001	PITTSFIELD	BERKSHIRE	78 CENTER STREET	Neighborhood	Population Exposure	12/1/1998	Pittsfield MSA	BAM <sub>2.5</sub>
25-003-0006	PITTSFIELD	BERKSHIRE	1 SOUTH STREET	Neighborhood	Population Exposure	12/1/2005	Pittsfield MSA	PM <sub>2.5</sub> (3-DAY)
25-013-0016	SPRINGFIELD	HAMPDEN	LIBERTY STREET	Neighborhood	-Population Exposure -Maximum Concentration	4/1/1988	Springfield MSA	PM <sub>2.5</sub> (2) (3-DAY), BAM <sub>2.5</sub> BLACK CARBON
25-013-2009	SPRINGFIELD	HAMPDEN	1860 MAIN STREET	Middle	-Population Exposure -Maximum Concentration	1/1/2002	Springfield MSA	Pb, PM <sub>10</sub> (LV), PM <sub>2.5</sub> (3-DAY)
25-001-0002	TRURO	BARNSTABLE	FOX BOTTOM AREA	Regional	General / Background	4/1/1987	No MSA; Downwind Providence-Pawtucket, RI	IMPROVE PM <sub>2.5</sub> (3-DAY) SITE
25-015-4002	WARE	HAMPSHIRE	QUABBIN SUMMIT	Neighborhood	Population Exposure	6/1/1985	Springfield MSA	PM <sub>10</sub> (LV), BAM <sub>2.5</sub> , IMPROVE PM <sub>2.5</sub> (3-DAY) SITE
25-027-0016	WORCESTER	WORCESTER	2 WASHINGTON STREET	Neighborhood	Population Exposure	10/1/2003	Boston CMSA; Worcester MSA	PM <sub>2.5</sub> (3-DAY)
25-027-0023	WORCESTER	WORCESTER	SUMMER STREET	Neighborhood	Population Exposure	1/1/2004	Boston CMSA; Worcester MSA	PM <sub>10</sub> (LV), PM <sub>2.5</sub> (2)(3-DAY), BAM <sub>2.5</sub>

## V. A-2 MONITOR COVERAGE AREA

Exhibits 5A-2 and 5A-3 show the coverage area of each PM<sub>2.5</sub> monitor. These maps were developed using EPA's Network Assessment Areas Served Tool that calculates the voronoi polygons for each monitor, based on its latitude and longitude. (Please see Section I for an explanation of the voronoi polygons.) This was one of several tools developed by EPA to assist states in the development of the 5-Year Network Assessment.

Exhibit 5A-2 PM<sub>2.5</sub> Federal Reference Method sites (1- and 3-day sites)

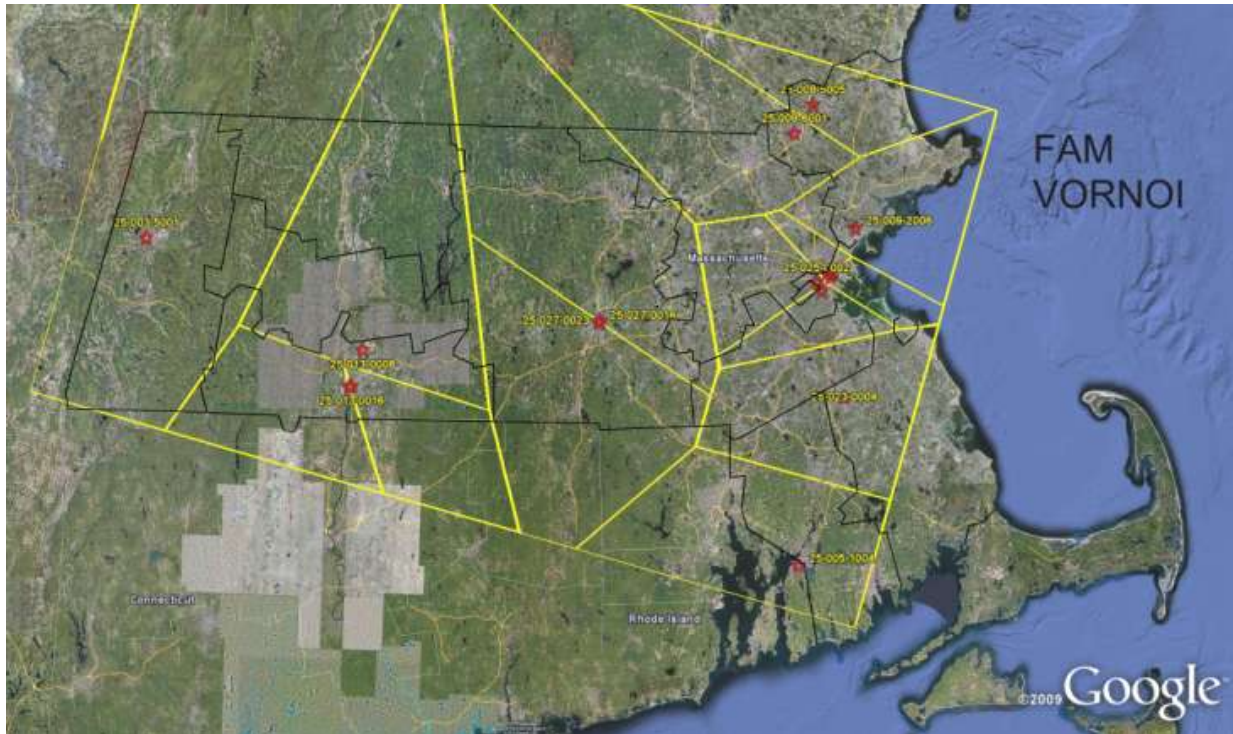
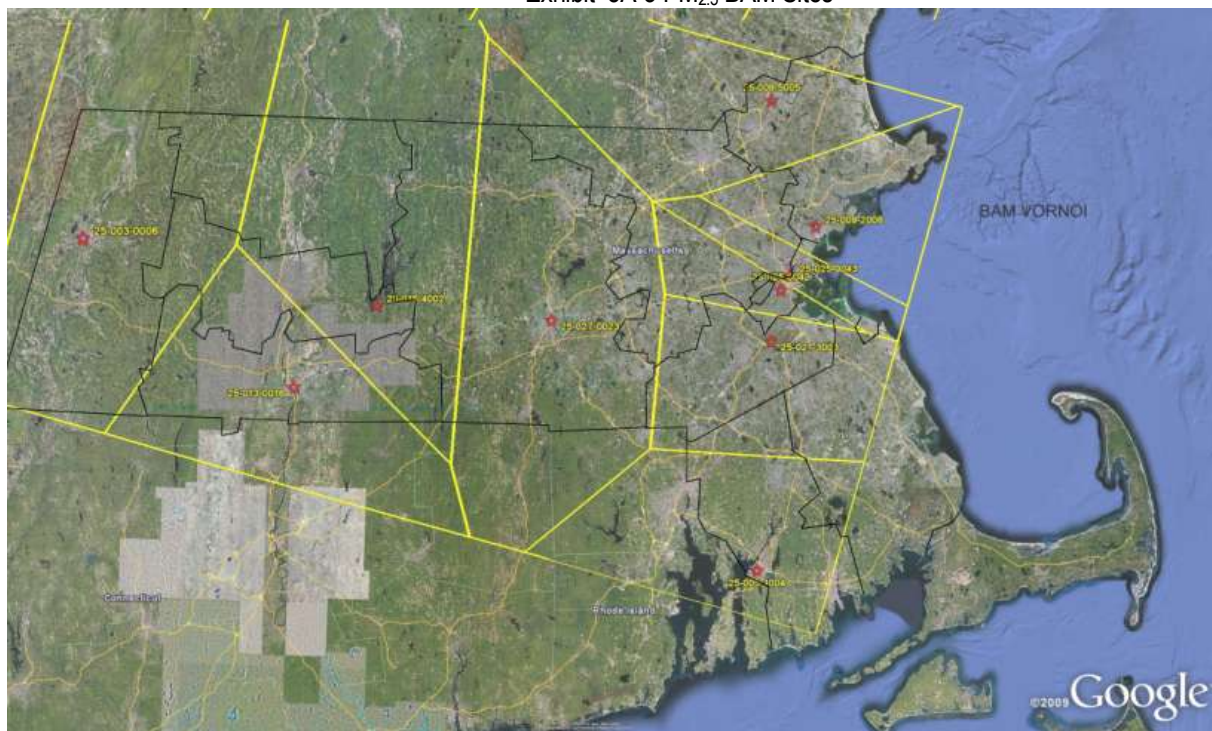


Exhibit 5A-3 PM<sub>2.5</sub> BAM Sites



## V. A-3 PM<sub>10</sub> MONITORING DATA

### 2009 PM<sub>10</sub> Data Summary

Exhibit 5A-4 shows a summary of the 2009 PM<sub>10</sub> data. There were 6 PM<sub>10</sub> sites in operation during 2009 in the state-operated monitoring network. All of the sites achieved data capture requirements for the year.

Exhibit 5A-4

SITE ID	TYPE	CITY	COUNTY	ADDRESS	%OBS	1ST MAX	2ND MAX	3RD MAX	4TH MAX	DAY MAX >150	EST DAYS >150	WTD ARITH MEAN
25-013-2009	Lo-Vol	Springfield	Hampden	1860 MAIN ST	95	40	38	38	32	0	0	15.9
25-015-4002	Lo-Vol	Ware	Hampshire	QUABBIN SUMMIT	84	32	24	22	19	0	0	9.8
25-025-0002	Lo-Vol	Boston	Suffolk	KENMORE SQUARE	70	69	43	36	35	0	0	20.6
25-025-0027	Lo-Vol	Boston	Suffolk	ONE CITY SQUARE	100	44	42	32	32	0	0	17.9
25-025-0042	Hi-Vol	Boston	Suffolk	HARRISON AVENUE	95	32	31	27	26	0	0	13.7
25-025-0042	Hi-Vol Co-loc	Boston	Suffolk	HARRISON AVENUE	97	34	31	27	25	0	0	13.8
25-025-0042	Lo-Vol	Boston	Suffolk	HARRISON AVENUE	97	40	34	31	25	0	0	15.6
25-025-0042	Lo-Vol Co-loc	Boston	Suffolk	HARRISON AVENUE	93	47	38	35	29	0	0	16.0
25-027-0023	Lo-Vol	Worcester	Worcester	SUMMER STREET	98	85	67	39	36	0	0	19.2

PM<sub>10</sub> Hi Vol Standards: 24-hour = 150 µg/m<sup>3</sup>

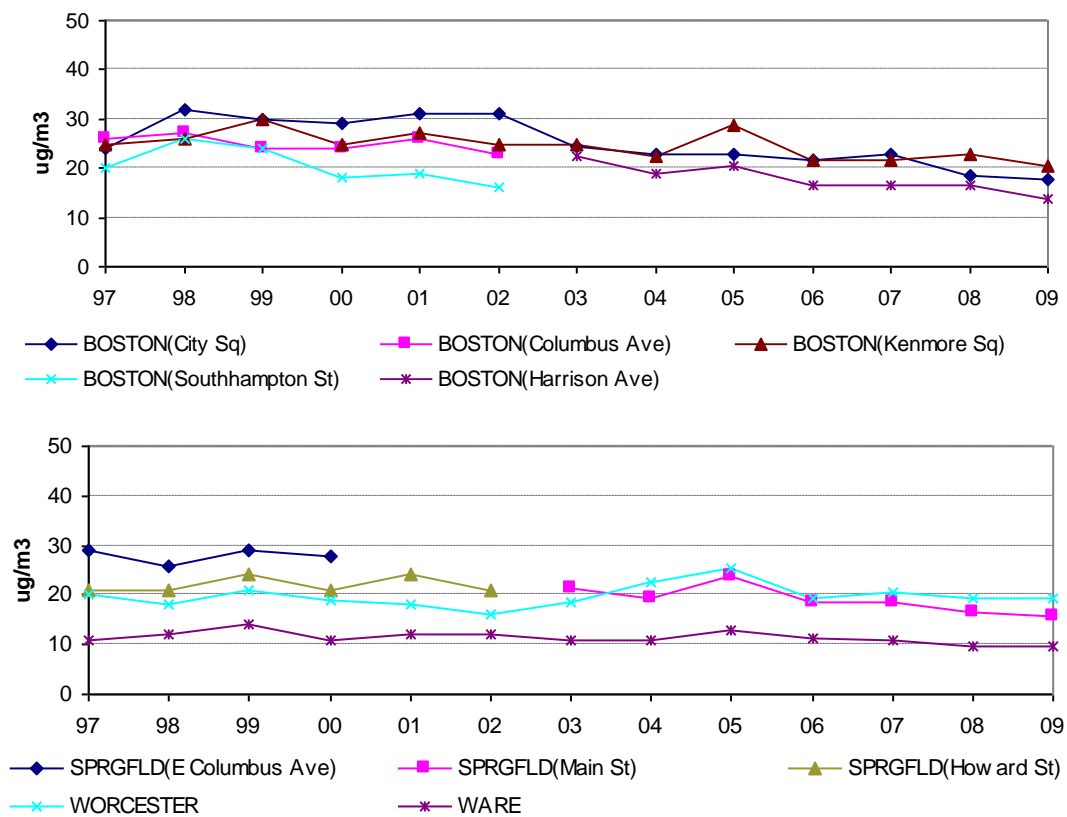
#### ABBREVIATIONS AND SYMBOLS USED IN TABLE

SITE ID = AIRS SITE IDENTIFICATION NUMBER % OBS = DATA CAPTURE PERCENTAGE 1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup>, 4<sup>TH</sup> 24-HR MAX = 1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup>, AND 4<sup>TH</sup> HIGHEST 24-HOUR VALUES FOR THE YEAR DAY MAX > 150 = DAILY MAXIMUM VALUE GREATER THAN STANDARD OF 150 µg/m<sup>3</sup> WTD ARITH MEAN = WEIGHTED ANNUAL ARITHMETIC MEAN

## PM<sub>10</sub> Trends

Exhibit 5A-5 shows long-term trends for each PM<sub>10</sub> site using the annual arithmetic mean as an indicator. The data shows a yearly variability at most sites, with the overall trend being downward.

Exhibit 5A-5  
PM<sub>10</sub> Trends 1989-2009 Annual Arithmetic Mean



## V. A-4 PM<sub>2.5</sub> MONITORING DATA

### PM<sub>2.5</sub> 2009 Data Summary

Exhibit 5A-6 shows a summary of the 2009 PM<sub>2.5</sub> data.

Exhibit 5A-6  
2009 PM<sub>2.5</sub> FRM Annual Data Summary

SITE ID	TYPE	CITY	COUNTY	ADDRESS	% OBS	1ST MAX	2ND MAX	3RD MAX	4TH MAX	98TH PERCENTILE VALUE	WTD ARITH MEAN
25-025-0002	FRM	Boston	Suffolk	KENMORE SQUARE	73	23.9	19.1	19.0	18.2	19.1	8.98*
25-025-0027	FRM	Boston	Suffolk	ONE CITY SQUARE	99	29.9	24.3	22.0	20.0	22.0	9.8
25-025-0042	FRM	Boston	Suffolk	HARRISON AVENUE	95	27.9	22.5	21.3	17.8	21.3	8.7
25-025-0043	FRM	Boston	Suffolk	174 NORTH STREET	97	31.4	29.1	28.2	26.0	24.1	10.2
25-025-0043	FRM Co-loc	Boston	Suffolk	174 NORTH STREET	94	29.1	27.8	26.5	25.2	24.2	10.3
25-023-0004	FRM	Brockton	Plymouth	COMMERCIAL STREET	97	24.0	22.5	21.8	20.8	21.8	8.4
25-023-0004	FRM Co-loc	Brockton	Plymouth	COMMERCIAL STREET	84	23.9	23.2	22.1	19.5	22.1	8.38*
25-013-0008	FRM	Chicopee	Hampden	ANDERSON RD AFB	100	31.2	27.6	25.0	19.5	25.0	7.8
25-013-0008	FRM Co-loc	Chicopee	Hampden	ANDERSON RD AFB	98	28.4	28.2	26.7	19.8	26.7	8.0
25-005-1004	FRM	Fall River	Bristol	659 GLOBE STREET	97	22.1	22.0	21.2	19.5	21.2	8.1
25-009-5005	FRM	Haverhill	Essex	CONSENTINO SCHOOL	98	29.7	22.8	20.2	18.9	20.2	7.6
25-009-6001	FRM	Lawrence	Essex	SHATTUCK STREET	97	30.6	22.7	20.8	18.6	20.8	8.5
25-009-2006	FRM	Lynn	Essex	390 PARKLAND	97	28.1	22.5	20.2	16.3	20.2	7.5
25-003-5001	FRM	Pittsfield	Berkshire	78 CENTER STREET	98	28.3	24.7	24.5	23.5	24.5	8.7
25-013-0016	FRM	Springfield	Hampden	LIBERTY PARKING LOT	97	32.6	28.9	26.8	23.5	26.8	9.4
25-013-2009	FRM	Springfield	Hampden	1860 MAIN STREET	98	31.1	30.3	29.7	22.5	29.7	9.2
25-027-0016	FRM	Worcester	Worcester	WASHINGTON ST	97	29.4	25.7	23.1	19.7	23.1	8.53
25-027-0023	FRM	Worcester	Worcester	SUMMER ST	97	30.3	25.7	22.8	22.8	22.8	9.17

\* indicates that the mean does not satisfy summary criteria for one quarter

#### ABBREVIATIONS AND SYMBOLS USED IN TABLE

SITE ID = AIRS SITE IDENTIFICATION TYPE = TYPE OF INSTRUMENT 1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup>, 4<sup>TH</sup> MAX = 1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup>, AND 4<sup>TH</sup> HIGHEST 24-HOUR VALUES FOR THE YEAR WTD ARITH MEAN = WEIGHTED ANNUAL ARITHMETIC MEAN (STANDARD = 15.0 µg/m<sup>3</sup>)

### PM<sub>2.5</sub> Design Values

The design value is a statistic that describes the air quality measured by a monitor relative to the National Ambient Air Quality Standards (NAAQS) in order to classify attainment and nonattainment areas, assess progress towards meeting the NAAQS, and develop control strategies. Design values are defined in EPA guidance and are based on the NAAQS in 40 CFR Part 50. They often require multiple years of data that help to ensure a stable indicator. EPA computes and publishes design values for each monitor annually.

The annual PM<sub>2.5</sub> design value is computed at each site by averaging the daily FRM samples taken each quarter, averaging these quarterly averages to obtain an annual average, and then averaging three years of annual averages. The 24-hour (“daily”) standard design value is computed at each site by determining the 98<sup>th</sup> percentile of the daily FRM samples taken in a given year for each of the three years, and then averaging these three numbers. Because design

values are computed over a 3-year time period they are more “stable” than the measurements recorded in any one year.

Exhibit 5A-7 shows the most recent design values for each PM<sub>2.5</sub> FRM monitor.

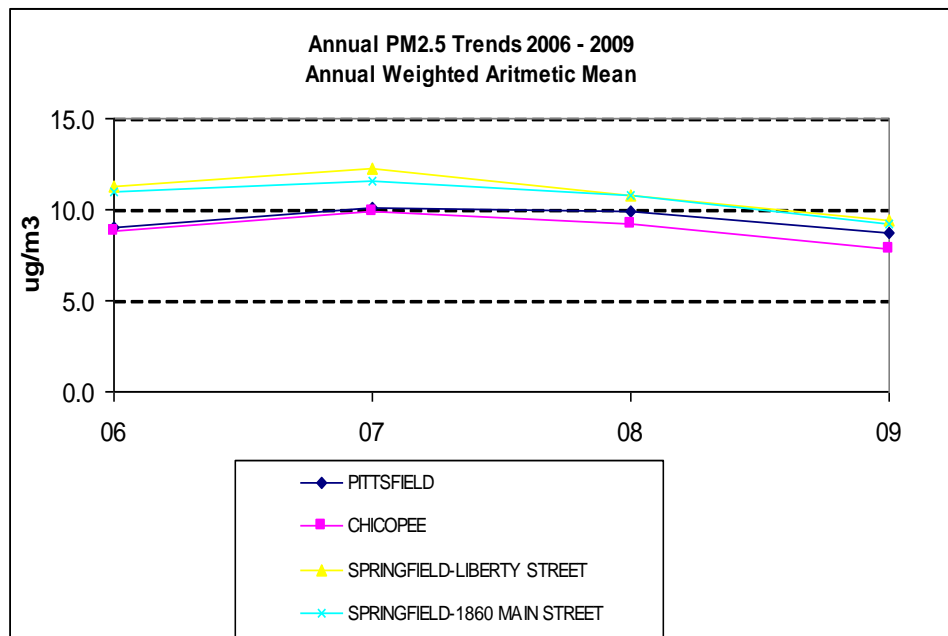
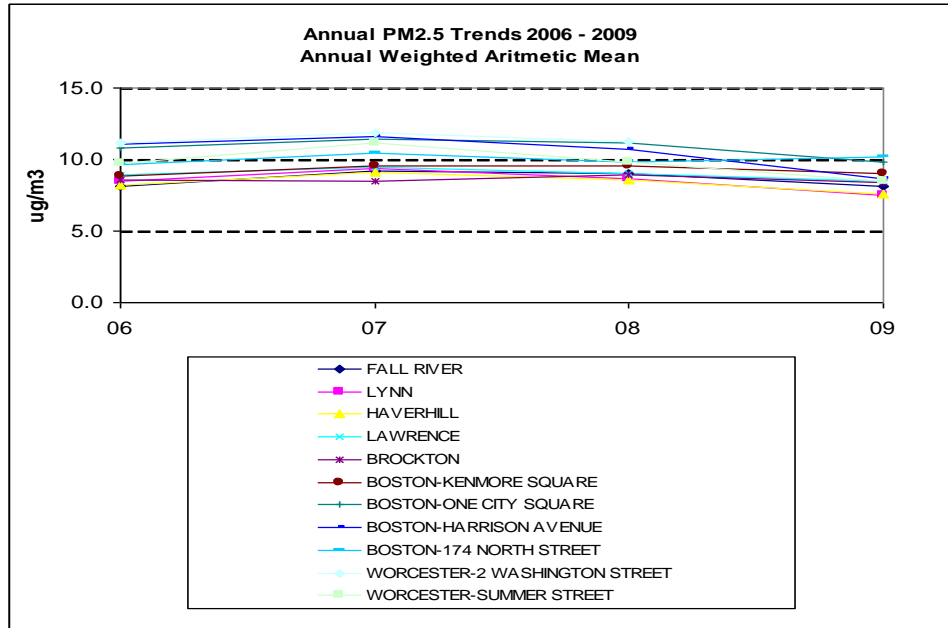
Exhibit 5A-7  
FRM PM<sub>2.5</sub> 2009 Design Value for Each Monitor

SITE ID	TOWN/ADDRESS	2006-2009 PM <sub>2.5</sub> DESIGN VALUE	
		ANNUAL STANDARD = 15 UG/M <sup>3</sup>	24 HOUR STANDARD = 35 UG/M <sup>3</sup>
25-003-5001	PITTSFIELD	9.7	27
25-013-0008	CHICOPEE	8.8	25
25-013-0016	SPRINGFIELD-LIBERTY STREET	8.8	26
25-013-2009	SPRINGFIELD-1860 MAIN STREET	8.7	25
25-005-1004	FALL RIVER	9.1	27
25-009-2006	LYNN	9.3	28
25-009-5005	HAVERHILL	11.4	31
25-009-6001	LAWRENCE	11.1	31
25-023-0004	BROCKTON	8.7	22
25-025-0002	BOSTON-KENMORE SQUARE	9.3	28
25-025-0027	BOSTON-ONE CITY SQUARE	11.1	29
25-025-0042	BOSTON-HARRISON AVENUE	11.1	27
25-025-0043	BOSTON-174 NORTH STREET	10.0	28
25-027-0016	WORCESTER-2 WASHINGTON STREET	11.4	28
25-027-0023	WORCESTER-SUMMER STREET	10.2	29

### **PM<sub>2.5</sub> Monitoring Data Trends**

Exhibit 5A-8 shows the trends in PM<sub>2.5</sub> ambient level data from FRM monitors in the state.

Exhibit 5A-8  
PM<sub>2.5</sub> Annual Standard Trends



## 2009 PM<sub>2.5</sub> BAM Data Summary

Exhibit 5A-8 shows a summary of the 2009 BAM PM<sub>2.5</sub> data.

Exhibit 5A-8  
2009 BAM Data Summary

SITE ID	CITY	COUNTY	ADDRESS	% OBS	1ST MAX	2ND MAX	3RD MAX	4TH MAX	ARITH MEAN
25-025-0042	Boston	Suffolk	HARRISON AVENUE	98	107.8	91.2	48.7	45.0	9.98
25-025-0043	Boston	Suffolk	174 NORTH STREET	93	67.7	52.1	51.3	44.9	9.39
25-005-1004	Fall River	Bristol	659 GLOBE STREET	97	53.8	49.3	43.3	43.0	7.99
25-009-5005	Haverhill	Essex	CONSENTINO SCHOOL	84	41.1	39.4	37.4	37.3	7.58
25-009-2006	Lynn	Essex	390 PARKLAND	99	111.5	68.1	47.9	42.1	8.22
25-021-3003	Milton	Norfolk	BLUE HILL OBSERVATORY	95	43.0	41.7	41.1	39.7	7.35
25-003-0006	Pittsfield	Berkshire	BERKSHIRE COMMONS	86	80.0	74.8	67.9	67.0	10.21
25-013-0016	Springfield	Hampden	LIBERTY PARKING LOT	98	190.6	92.7	88.5	70.6	10.71
25-015-4002	Ware	Hampshire	QUABBIN SUMMIT	92	47.5	46.5	46.0	41.3	8.70
25-027-0023	Worcester	Worcester	SUMMER STREET	90	63.8	61.3	56.9	53.9	8.51

### ABBREVIATIONS AND SYMBOLS USED IN TABLE

SITE ID = AIRS SITE IDENTIFICATION TYPE = TYPE OF INSTRUMENT 1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup>, 4<sup>TH</sup> MAX = 1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup>, AND 4<sup>TH</sup> HIGHEST 24-HOUR VALUES FOR THE YEAR WTD ARITH MEAN = WEIGHTED ANNUAL ARITHMETIC MEAN (STANDARD = 15.0 ug/m<sup>3</sup>)

## V. A-5 PM MONITORING TECHNOLOGY

### PM<sub>10</sub>

MassDEP uses low volume size-selective gravimetric filters. The FRM monitor works by drawing air through a small Teflon filter for 24 hours (midnight to midnight) on the designated sample day, after which the filter is removed from the monitor and transported to the MassDEP Laboratory in Lawrence for weighing. The samples are run every 6<sup>th</sup> day for 24 hours.

### PM<sub>2.5</sub>

MassDEP operates 15 FRM filter-based monitors and 10 BAMs monitors for measuring PM<sub>2.5</sub> concentrations at locations throughout the state. In Massachusetts, the PM<sub>2.5</sub> FRM monitor is identical to the PM<sub>10</sub> monitor with the addition of a cyclone on the air intake to select for particles that are 2.5 micron or below. Filter-based monitors have several disadvantages:

- There is a time interval between when the sample is collected and the data is available
- The samples do not provide a continuous analysis of air quality
- There is extra staff time and expense associated with:
  - visiting sites to collect the samples and bring them to the laboratory for analysis
  - conducting the necessary sample management and analysis quality assurance.

BAMs monitors make it possible to collect and report  $PM_{2.5}$  concentrations on an hourly basis without having to transport the filters and weigh them in the laboratory. EPA has approved BAMs monitoring technology as a Federal Equivalent Method (FEM) and MassDEP has obtained FEM status for 9 of its 10 BAMs. MassDEP plans to obtain FEM status for the 10<sup>th</sup> monitor during FFY11.

While BAMs have advantages, they also have some disadvantages. They require temperature controlled enclosures and telephone-based telemetry to obtain the most value from the measurements (such as mapping and near real-time reporting), and some current roof-top sites would not support this type of installation.

Because of the potential labor cost savings from using BAMs and the fact that the existing FRM monitors are nearing the end of their useful life, MassDEP will explore the feasibility and desirability of upgrading as many of its FRM monitors to BAMs as possible over the coming five years.

### **$PM_{coarse}$ ( $PM_{10} - PM_{2.5}$ )**

MassDEP will begin using the Federal Reference Method (FRM) for  $PM_{coarse}$  in compliance with NCore requirements at the NCore site at Boston-Harrison Avenue (Roxbury) beginning in January 2011. This method consists of the subtraction of  $PM_{2.5}$  values from  $PM_{10}$  values at a site that has side-by-side monitors of each type of sampling on the same dates. Harrison Avenue currently has monitors of the appropriate types. MassDEP has no current plans to measure  $PM_{coarse}$  at any of the other four  $PM_{10}/PM_{2.5}$  collocated sites in Massachusetts at this time.

MassDEP will monitor closely the development and FEM designations of new  $PM_{coarse}$  monitoring equipment. It should be noted that the Harrison Avenue NCore site has the FRM low volume  $PM_{10}$  and  $PM_{2.5}$  configuration needed for calculating  $PM_{coarse}$  values. Over the last few years, EPA has been evaluating the potential health effects of this PM fraction.

### **Speciation**

MassDEP has been collecting  $PM_{2.5}$  samples for speciation at the Boston-Harrison Avenue air monitoring station since 2000 and in Chicopee since 2001. Speciation is the analysis of particulate matter collected on Teflon, nylon and quartz filters simultaneously to determine the chemical composition of the particulate matter collected. During each sampling event, the three separate filters are collected and shipped to an out-of-state national contract laboratory for analysis. Each different filter medium is analyzed for a different category of pollutant. These include elements (e.g., metals), sulfates and nitrates, and carbon (total and organic). MassDEP upgraded these sites to the new carbon method (comparable to the IMPROVE method) in 2009. Note that the IMPROVE monitors acquire  $PM_{2.5}$  filter samples for speciation analysis using a different protocol than that of the speciation program. At this point in time, MassDEP does not see a need to change either the IMPROVE or the speciation methods.

## V. A-6 ADEQUACY OF THE PM NETWORK

### EPA Requirements

As demonstrated in Exhibits 5A-9 and 5A-10, the PM network meets or exceeds federal requirements for PM<sub>10</sub>, PM<sub>2.5</sub>, and speciation. The only required monitors for PM<sub>coarse</sub> are those required at NCore sites. MassDEP will operate a PM<sub>coarse</sub> monitor at its NCore site at Boston-Harrison Avenue beginning in January 2011.

Exhibit 5A-9  
PM<sub>10</sub> Monitor Siting Requirements

	POPULATION	# MONITORS REQUIRED IF AMBIENT LEVEL IS ≥ 20% OF NAAQS (HIGH CONCEN- TRATION)	# MONITORS REQUIRED IF AMBIENT LEVEL IS ≥ 80% OF NAAQS (MEDIUM CONCEN- TRATION)	# MONITORS REQUIRED IF AMBIENT LEVEL IS < 80% OF NAAQS OR IF NO DESIGN VALUE (LOW CONCEN- TRATION)				
EPA Require- ments for # of PM <sub>10</sub> Monitors	>1,000,000	6-10	4-8	2-4				
	500,000- 1,000,000	4-8	2-4	1-2				
	250,000- 500,000	3-4	1-2	0-1				
	100,000- 250,000	1-2	0-1	0				
MSA / CSA	POPULATION				MAXIMUM ANNUAL MEAN FOR ANY MONITOR IN MSA/CSA	MAXIMUM ANNUAL MEAN AS A % OF STANDARD	# MONITORS NEEDED	# MONITORS IN NETWORK
Boston- Worcester- Manchester, MA-RI-NH CSA	7,609,358			X	20	13%	2-4	4
Pittsfield, MA Metro Area	129,288			X	no dv		0	0
Springfield, MA Metro Area	698,903			X	20	13%	0	2
Barnstable Town, MA Metro Area	221,151			X	no dv		0	0

Exhibit 5A-10  
PM<sub>2.5</sub> Monitor Siting Requirements, including Speciation

EPA REQUIREMENTS FOR NUMBER OF PM <sub>2.5</sub> MONITORS	MSA POPULATION	MOST RECENT 3- YEAR DESIGN VALUE ≥85% OF ANY PM <sub>2.5</sub> NAAQS		MOST RECENT 3- YEAR DESIGN VALUE <85% OF ANY PM <sub>2.5</sub> NAAQS OR NO DESIGN VALUE				
	>1,000,000	3		2				
	500,000– 1,000,000	2		1				
	50,000– <500,000	1		0				
CSA / MSA	POPULATION	3 YEAR DESIGN VALUES (MAXIMUM FOR ANY MONITOR IN CSA / MSA)				> 85% OF ANY NAAQS?	# MONITORS NEEDED	# MONITORS IN NETWORK
		ANNUAL		24 HOUR				
		VALUE	% OF STD	VALUE	% OF STD			
Boston-Worcester-Manchester, MA-RI-NH CSA	7,609,358	11.4	76%	29	83%	NO	2	12
Pittsfield, MA Metro Area	129,288	9.7	65%	27	77%	NO	0	1
Springfield, MA Metro Area	698,903	11.4	76%	31	89%	YES	1	3
Barnstable Town, MA Metro Area	221,151	no dv		no dv		NO	0	0
ADDITIONAL PM <sub>2.5</sub> MONITOR REQUIREMENTS					BOSTON-WORCESTER- MANCHESTER, MA-RI- NH CSA		SPRINGFIELD, MA METRO AREA	PITTSFIELD, MA METRO AREA (NOT REQUIRED)
At least one monitoring station is to be sited in a population-oriented area of expected maximum concentration.					Boston-Kenmore Boston- One City Square, - Boston-North End Fall River		Liberty Street Main Street	
For areas with more than one required SLAMS, a monitoring station is to be sited in an area of poor air quality.					Boston-Kenmore Boston-One City Square Boston-North End Fall River		Liberty Street & Main Street	
The State, or where appropriate, local agencies must operate continuous PM <sub>2.5</sub> analyzers equal to at least one-half (round up) the minimum required sites listed in Table D–5 of this appendix. At least one required continuous analyzer in each MSA must be collocated with one of the required FRM/FEM/ARM monitors, unless at least one of the required FRM/FEM/ARM monitors is itself a continuous FEM or ARM monitor in which case no collocation requirement applies.					7 Continuous 5 Collocated		2 Continuous 1 Collocated	1 Continuous
Each State shall install and operate at least one PM <sub>2.5</sub> site to monitor for regional background and at least one PM <sub>2.5</sub> site to monitor regional transport. These monitoring sites may be at community-oriented sites and this requirement may be satisfied by a corresponding monitor in an area having similar air quality in another State. Methods used at these sites may include non-federal reference method samplers such as IMPROVE or continuous PM <sub>2.5</sub> monitors					Ware IMPROVE station			
Each State shall continue to conduct chemical speciation monitoring and analyses at sites designated to be part of the PM <sub>2.5</sub> Speciation Trends Network (STN).					1		1	

## Correlations, New Sites, Removal Bias Data

In order to assist states prepare the 5-Year Assessment, EPA developed three analytical tools for identifying potentially underserved areas and redundant sites. They include:

- Identifying potential new sites based on correlations between existing site measurements, distance between sites and the likelihood of the site exceeding a standard
- Evaluating the correlation between site measurements
- Estimating the removal bias – the difference between the measured concentrations at a site and those that would be estimated for that site based on data from surrounding sites

These tools produce files that display the information graphically as well as present the data in spreadsheets and database files. The tools and their documentation can be found at: [www.epa.gov/ttn/amtic/netassess/documentation/draft\\_Network\\_Assessment\\_tools\\_documentation.doc](http://www.epa.gov/ttn/amtic/netassess/documentation/draft_Network_Assessment_tools_documentation.doc)

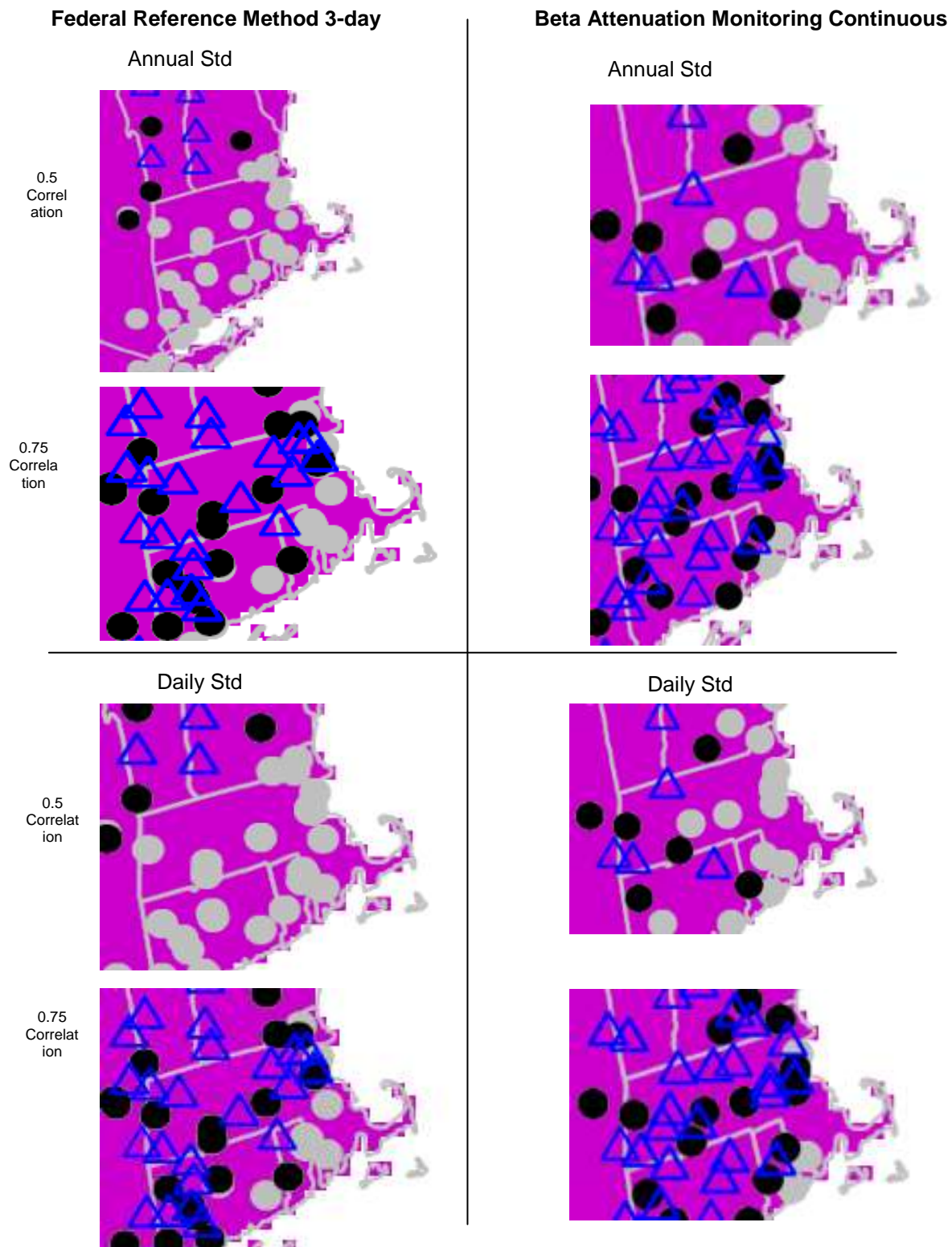
### New Sites Analysis

Exhibit 5A-10 shows the results of the new sites analysis. The tool identifies areas in the state where a new monitor would be less correlated with its neighbors than a specific level the user sets. The higher the desired correlation between sites, the more “new sites” the tool will suggest. MassDEP ran the tool using 2008 data for the annual and daily PM<sub>2.5</sub> standard, for the FRM 3-day monitoring sites and the BAM continuous sites, at two different correlation coefficients: 0.50 and 0.75.

The resulting maps have triangles at the suggested spots for new monitors. The triangles are located at the midpoint between any two adjacent monitors. Gray dots indicate monitors that are correlated at or above the selected correlation level. Dark dots indicate monitors that have a lower correlation than the selected level.

The maps show that the annual and daily results are almost identical. The results for the BAM and FRM monitors are similar; however, the BAM data indicates lower correlations between monitors than does the FRM data, and identifies more potential locations for additional monitors. The biggest difference is between the two correlation levels. At the 0.75 correlation between sites, the map indicates many potential sites for additional monitors, including central Middlesex County, Franklin County and Berkshire County. At the 0.50 correlation level for BAM monitors, the analysis indicates a possible new monitor in Franklin County and in the relatively sparsely populated southwestern corner of Berkshire County. It is important to note that because there are no monitors East of Fall River and Boston, Cape Cod is not included in the analysis. So the lack of a triangle on the Cape merely indicates only that there were no monitors with which to correlate to, rather than that there were monitors measuring different air pollution levels.

Exhibit 5A-10  
Potential New PM Sites based on 2008 Data Correlations



## Site Correlation Analysis

Exhibit 5A-11 shows the correlation between the measured air quality in 2008 at each BAM monitoring site in Massachusetts. The narrower the ellipse, the higher the correlation between the two sites. The lighter the color the lower the difference between measured results. (The correlations between Massachusetts sites and all nearby sites are below and to the right of the two dark lines. The correlations between Massachusetts sites only are to the right of the dashed line.) The analysis shows that many of the Massachusetts BAM and FRM sites have at least a 0.6 correlation with each other. These data also are available for other years and in a format that has been entered into an Access data base.

Exhibit 5A-11  
BAM Site Correlations 2008

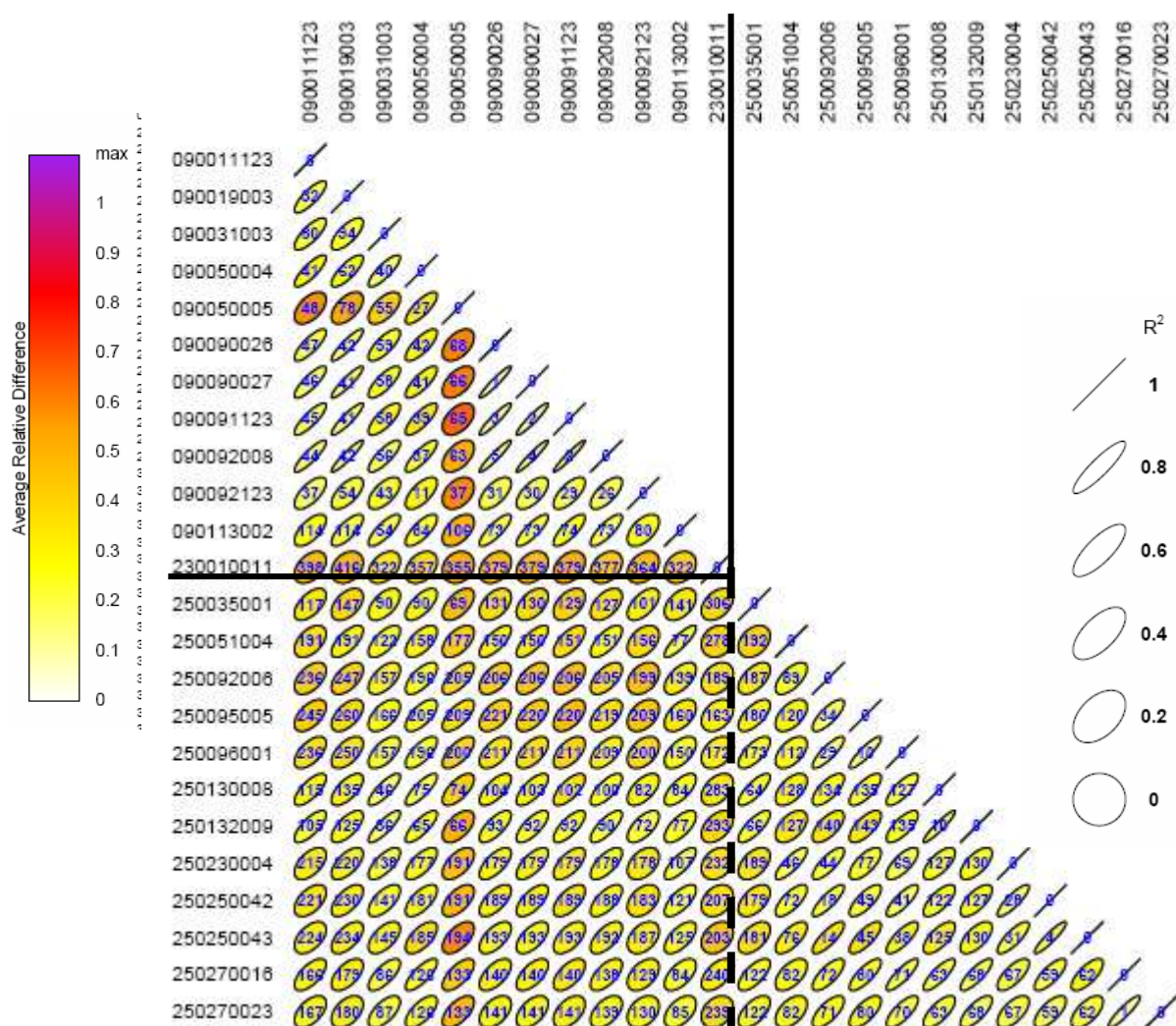
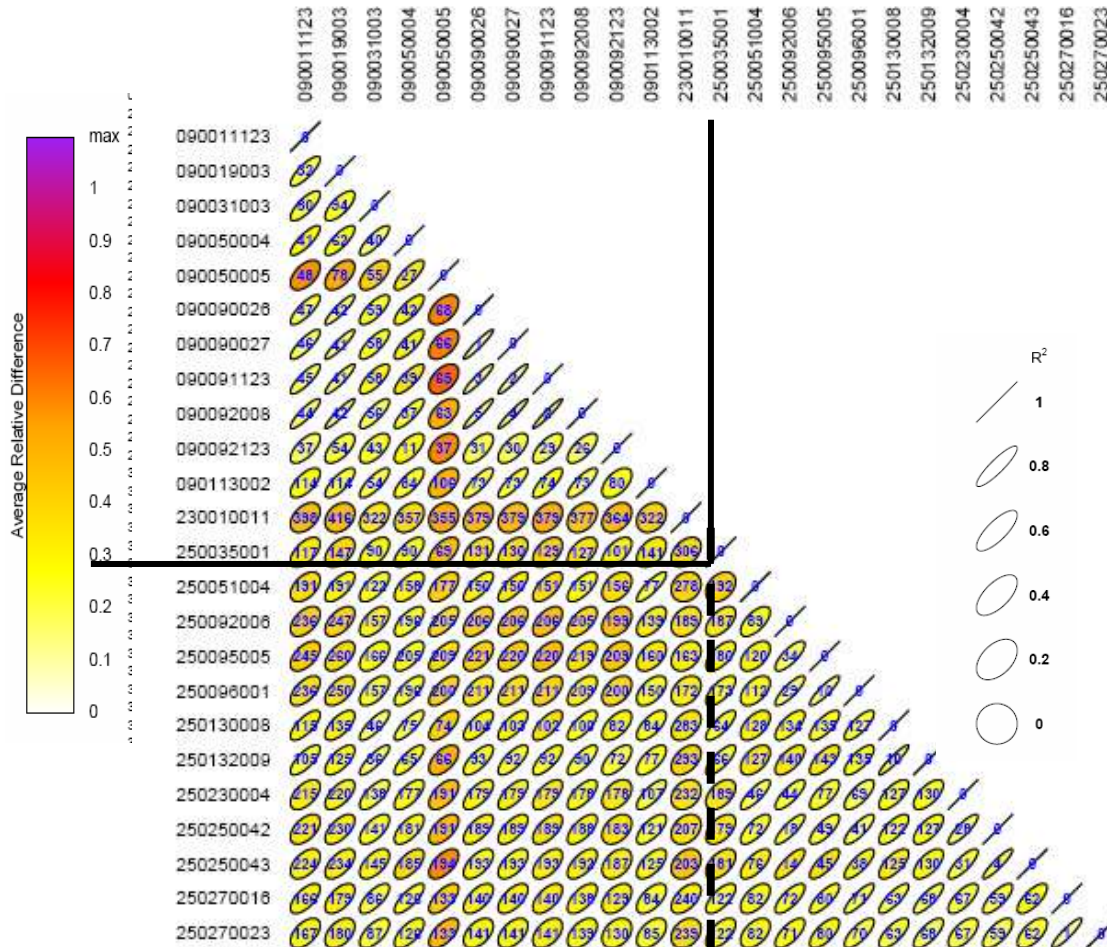


Exhibit 5A-11 shows the same information for FRM 3-day monitors:

Exhibit 5A-11  
PM<sub>2.5</sub> (3-Day) FRM Monitor Correlations 2008



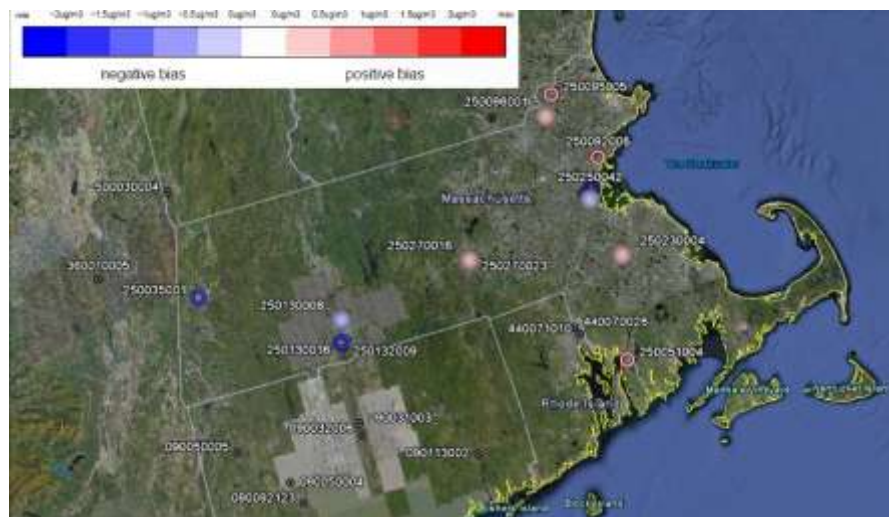
### Removal Bias Analysis

The final EPA tool calculates removal bias. Removal bias is a measure of the difference between the ambient concentration a monitor measures and the ambient concentration for that location that would be extrapolated from the levels measured at nearby monitors. A positive average bias would mean that if the site being examined was removed, the neighboring sites would indicate that the estimated concentration at the site would be larger than the measured concentration. If the site is solid colored it means that the removal bias is not statistically different. Exhibits 5A-12 and 5A-13 show the removal bias that would result from eliminating each PM<sub>2.5</sub> monitor.

A solid dot indicates that the predicted difference in monitored values would not be statistically significant, whereas a ring indicates that the difference would be statistically different. The darker the dot or ring, the greater the difference between the monitored value and that which would be predicted for the site in the absence of a monitor.

The data show that there would be statistically significant removal bias for about half of the FRM monitors and that the difference would be greater than plus or minus 1.5 micrograms per cubic meter. Pittsfield and Springfield show a negative removal bias, and Lynn, Haverhill and Fall River would show a positive removal bias.

Exhibit 5A-12  
Removal Bias for FRM PM<sub>2.5</sub> Monitors



The results for the BAM monitors show that there would be a statistically significant difference for every monitor except Pittsfield, and that the differences would be on the order of 1.5 micrograms per cubic meter.

Exhibit 5A-7  
Removal Bias for BAM Monitors



## V. A-7 MONITORING GAPS

On the basis of the above analysis, the potential PM monitoring gaps can be found in the northern Franklin County area and Barnstable County (Cape Cod). As outlined in the table below, there are factors that both support and mitigate the need for additional monitors in these two areas.

Exhibit 5A  
Factors Affecting The Need For New PM Monitors In Franklin And Berkshire Counties

Issue	Mitigating Factors	Supporting Factors
Franklin County		
Population	Sparsely populated: <ul style="list-style-type: none"> <li>71,778 people</li> <li>1% of state population</li> <li>102 people/sq mile; least densely populated county in the state</li> <li>Lower than the state average child population</li> </ul>	
Health	On a county wide basis well below state incidence rate on the four health concerns evaluated: <ul style="list-style-type: none"> <li>Lung/Bronchus cancer incidence per 100,000 people</li> <li>Respiratory Disease Related Hospitalizations per 100,000 people</li> <li>Asthma Related Hospitalizations per 100,000 people</li> <li>Circulatory Disease Related Hospitalizations per 100,000 people</li> </ul>	
Emissions		Increased use of biomass for residential heating could result in localized increases of PM <sub>2.5</sub> levels
Env. Justice		EJ areas in county
Other		No monitor in the entire county
Barnstable County		
Population	Sparse year round population <ul style="list-style-type: none"> <li>221,151 people</li> <li>3% of state population</li> <li>562 people/sq mile; 7<sup>th</sup> least dense county</li> <li>Lower than the state average child population</li> </ul>	High seasonal population
Health		On a county wide basis well above state incidence rate on three of the four health concerns evaluated: <ul style="list-style-type: none"> <li>Lung/Bronchus cancer incidence per 100,000 people</li> <li>Asthma Related Hospitalizations per 100,000 people</li> <li>Circulatory Disease Related Hospitalizations per 100,000 people</li> </ul>
Emissions		In the 2005 emissions inventory, Canal Electric was listed as a major source; however, in recent years this plant has not seen significant levels of operation and is not expected to in the future.
Env. Justice		There are several EJ areas on the Cape and the Islands
Other		The only monitor in the Barnstable -Nantucket County area is a seasonal ozone monitor in Truro

## V. B Ozone

### V. B-1 NETWORK DESCRIPTION

The Air Assessment Branch operates 15 ozone monitoring sites in 14 municipalities across the state. There is at least one state-operated ozone monitor located in each county except Franklin, Dukes (Martha's Vineyard), and Nantucket. The Wampanoag Tribe of Gay Head (Aquinnah) operates an ozone monitor in Dukes County. Due to construction activity, the Parker River National Wildlife Sanctuary site in Newbury was discontinued and replaced with a station in Newburyport approximately 2 miles to the north. MassDEP measures ozone and all other Photochemical Assessment Monitoring Station (PAMS) parameters at the new site. MassDEP used this location for measuring ozone from 1983 to 1994.

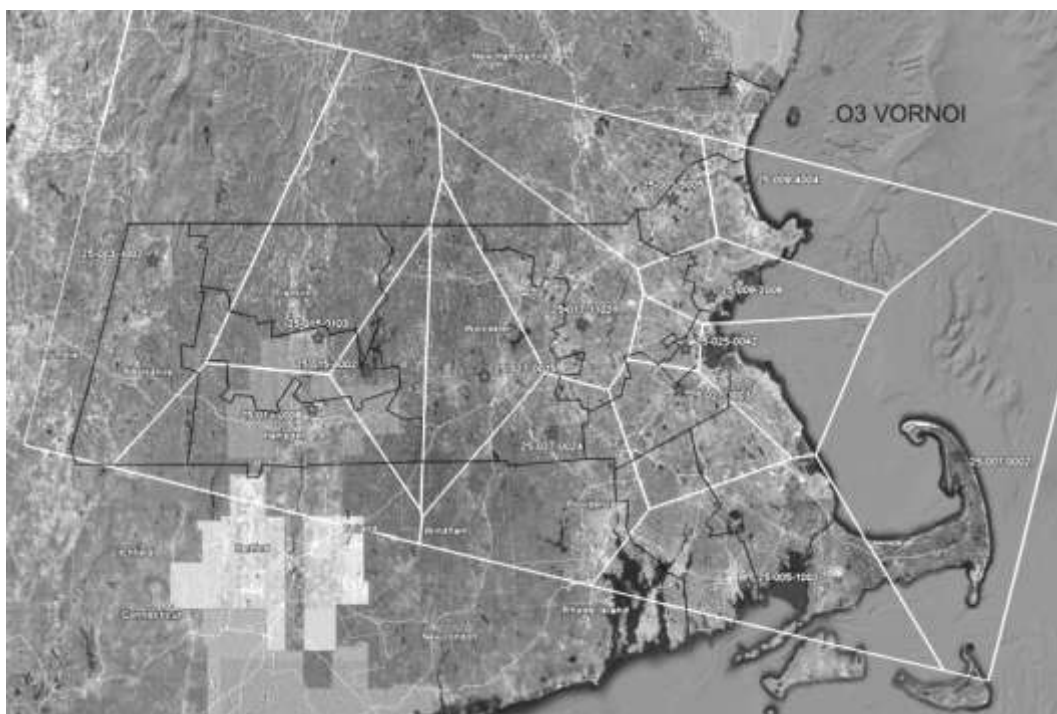
Exhibit 5B-1  
Ozone Monitoring Sites, Location, Scale and Purpose

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR MONITOR	YEAR ESTABLISHED	MSA/CMSA
25-003-4002	ADAMS	BERKSHIRE	MT. GREYLOCK	Regional	Highest Concentration	5/1/1989	Pittsfield MSA
25-015-0103	AMHERST	HAMPSHIRE	NORTH PLEASANT	Urban	Population Exposure	4/1/1988	Springfield MSA
25-025-0041	BOSTON	SUFFOLK	LONG ISLAND	Urban	-PAMS: Boston Type 2A (Maximum precursors) -Others: Area Background	12/1/1998	Boston CMSA; Boston Metropolitan MSA
25-025-0042	BOSTON	SUFFOLK	HARRISON AVENUE	Neighborhood	Population Exposure	12/15/1998	Boston CMSA; Boston Metropolitan MSA
25-013-0008	CHICOPEE	HAMPDEN	ANDERSON ROAD	Urban	-PAMS: Springfield Type 2 (Maximum Precursor) -Others: Population Exposure	1/1/1983	Springfield MSA
25-005-1002	FAIRHAVEN	BRISTOL	LEROY WOOD	Regional / Urban	Population Exposure	1/1/1982	Boston CMSA
25-009-5005	HAVERHILL	ESSEX	WASHINGTON STREET	Urban	Population Exposure	7/19/1994	Boston CMSA; Lawrence MSA
25-009-2006	LYNN	ESSEX	390 PARKLAND	Urban	-PAMS: Boston Type 2 (Maximum Precursor) -Ozone: Population Exposure	1/1/1992	Boston CMSA; Boston Metropolitan MSA
25-021-3003	MILTON	NORFOLK	MILTON MA, BLUE HILL	Urban	-PAMS: Boston Type 1 (Upwind Background) -PAMS Providence Type 3 (Maximum Concentration)	4/2/2002	Boston CMSA; Boston Metropolitan MSA
25-009-4005	NEWBURYPORT	ESSEX	261 NORTHERN BLVD	Urban	PAMS Boston Type 3 (Maximum Ozone Concentration) -Others: Population Exposure	6/2010 (note this replaced the former NEWBURY site)	Boston CMSA; Boston Metropolitan MSA
25-017-1102	STOW	MIDDLESEX	US MILITARY	Regional	-Maximum Ozone Concentration -Population Exposure	4/1/1998	Boston CMSA; Boston Metropolitan MSA

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR MONITOR	YEAR ESTABLISHED	MSA/CMSA
25-001-0002	TRURO	BARNSTABLE	FOX BOTTOM AREA	Regional	General / Background	4/1/1987	No MSA; Downwind Providence-Pawtucket, RI
25-027-0024	UXBRIDGE	WORCESTER	366 E. HARTFORD AVE.	Urban	-Ozone Transport (state line upwind) -Population Exposure	11/1/2008	Boston CMSA; Worcester MSA
25-015-4002	WARE	HAMPSHIRE	QUABBIN SUMMIT	Urban	-PAMS: Springfield Type 3 (Maximum Ozone Concentration)	6/1/1985	Springfield MSA
25-027-0015	WORCESTER	WORCESTER	WORCESTER AIRPORT	Urban	Worcester/Springfield Interface	5/7/1979	Boston CMSA; Worcester MSA

## V. B-2 MONITOR COVERAGE AREAS

Exhibit 5B-2  
Coverage Area of Each Ozone Monitor  
(Please see Section I for an explanation of how these maps are created)



## V. B-3 OZONE MONITORING DATA

Despite reductions in ozone pollution over the past 20 years, Massachusetts does not meet the 0.75 ppm 8-hour ozone standard adopted in 2008. In March 2009, Massachusetts recommended to EPA that the entire state be designated as nonattainment with this new standard. EPA is

reconsidering the 2008 ozone standard and expects to promulgate a more stringent standard in December 2010. As discussed in Section II, MassDEP is adopting aggressive controls on the ozone precursors nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOC) in coordination with the other Ozone Transport Commission (OTC) states to further reduce ozone concentrations. (See Section I for the list of OTC states.)

## 2009 Ozone Data Summary

A summary of the data collected during the 2009 ozone season (April 1 – Sept. 30) is shown below. All fifteen sites achieved the data capture standard of 75% or greater for the year with the exception of Newbury, which was shut down due to construction.

Exhibit 5B-3  
2009 Ozone Data Summary

SITE ID	CITY	COUNTY	ADDRESS	% OBS	1ST	2ND	DAY	1ST	2ND	3RD	4TH	DAY
					MAX	MAX	MAX>=	MAX	MAX	MAX	MAX	MAX >
					1-HR	1-HR	0.125	8-HR	8-HR	8-HR	8-HR	0.075
25-003-4002	Adams	Berkshire	MT GREYLOCK SUMMIT	84	0.087	0.082	0	0.083	0.079	0.075	0.066	2
25-025-0041	Boston	Suffolk	LONG ISLAND	98	0.089	0.086	0	0.081	0.080	0.076	0.075	3
25-025-0042	Boston	Suffolk	HARRISON AV	99	0.086	0.077	0	0.069	0.064	0.063	0.062	0
25-013-0008	Chicopee	Hampden	ANDERSON RD AFB	99	0.102	0.089	0	0.080	0.078	0.077	0.076	4
25-005-1002	Fairhaven	Bristol	LEROY WOOD SCHOOL	98	0.092	0.085	0	0.078	0.072	0.071	0.069	1
25-009-5005	Haverhill	Essex	CONSENTINO SCHOOL	98	0.084	0.084	0	0.075	0.074	0.073	0.070	0
25-009-2006	Lynn	Essex	390 PARKLAND	99	0.090	0.085	0	0.079	0.077	0.073	0.073	2
25-021-3003	Milton	Norfolk	BLUE HILL OBS	99	0.092	0.089	0	0.081	0.081	0.076	0.071	3
25-009-4004	Newbury	Essex	SUNSET BLVD	41	0.084	0.081	0	0.078	0.077	0.072	0.068	2
25-015-0103	North Amherst	Hampshire	N PLEASANT ST	93	0.088	0.083	0	0.076	0.073	0.071	0.070	1
25-017-1102	Stow	Middlesex	US MILITARY RES	98	0.088	0.084	0	0.082	0.078	0.077	0.071	3
25-001-0002	Truro	Barnstable	FOX BOTTOM AREA	97	0.095	0.091	0	0.082	0.078	0.073	0.071	2
25-027-0024	Uxbridge	Worcester	366 E HARTFORD	99	0.100	0.091	0	0.086	0.082	0.073	0.071	2
25-015-4002	Ware	Hampshire	QUABBIN SUMMIT	98	0.099	0.096	0	0.079	0.079	0.077	0.076	4
25-027-0015	Worcester	Worcester	WORC AIRPORT	98	0.100	0.092	0	0.082	0.082	0.080	0.077	4

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**  
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **% OBS** = PERCENTAGE OF VALID DAYS MONITORED DURING O3 SEASON **1<sup>ST</sup>, 2<sup>ND</sup> MAX 1-HR** = MAXIMUM 1-HR VALUE FOR THE 1<sup>ST</sup> & 2<sup>ND</sup> HIGHEST DAY **DAY MAX ≥ 0.125** = NUMBER OF MEASURED DAILY 1-HOUR MAXIMUM VALUES GREATER THAN OR EQUAL TO 0.125 PPM (1-HR STANDARD) **1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup> & 4<sup>TH</sup> MAX 8-HR** = MAXIMUM 8-HR VALUE FOR THE 1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup> & 4<sup>TH</sup> HIGHEST DAY **DAY MAX ≥ 0.075** = NUMBER OF MEASURED DAILY 8-HOUR MAXIMUM VALUES GREATER THAN OR EQUAL TO 0.075 PPM (8-HR STANDARD)

## Ozone Design Values

The design value is a statistic that describes the air quality measured by a monitor relative to the National Ambient Air Quality Standards (NAAQS) in order to classify attainment and nonattainment areas, assess progress towards meeting the NAAQS, and develop control strategies. Design values are defined in EPA guidance and are based on the NAAQS in 40 CFR Part 50. They often require multiple years of data that help to ensure a stable indicator. EPA computes and publishes design values for each monitor annually.

The 1997 8-hour NAAQS for ozone is 0.08 parts per million (ppm). The design value is the 3-year average of the annual fourth-highest daily maximum 8-hour ozone concentration. Exhibit 5B-4 shows ozone design values based on 2006 – 2008 monitored data.

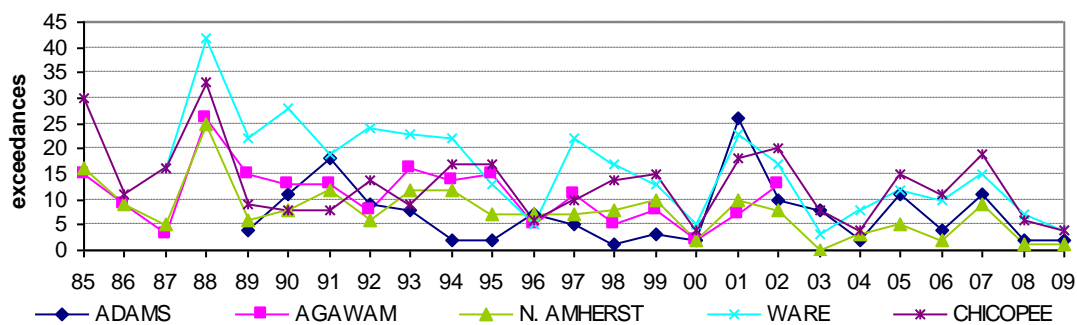
Exhibit 5B-4  
Ozone Monitor 2008 Design Values

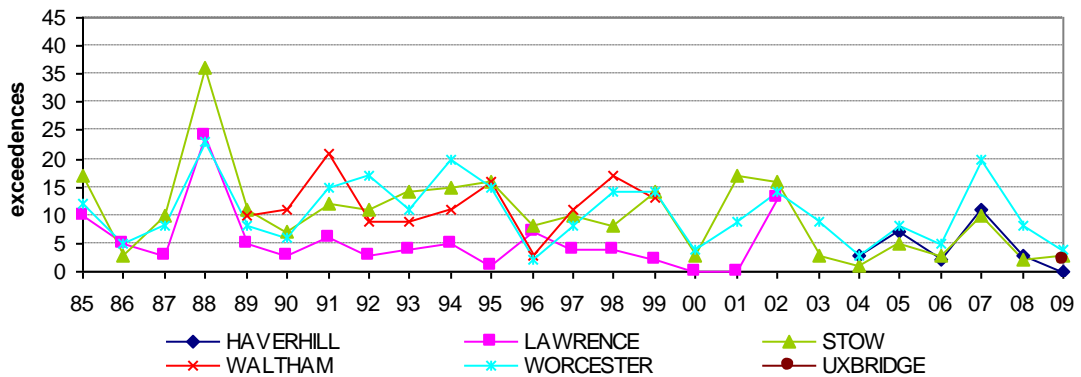
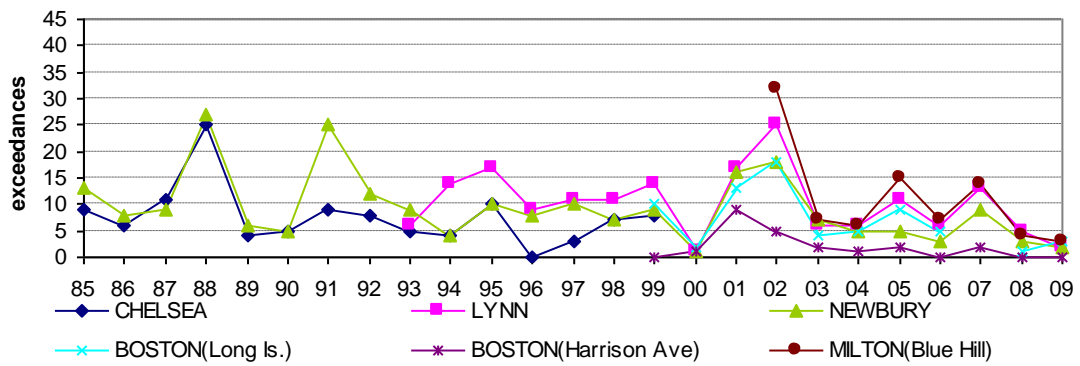
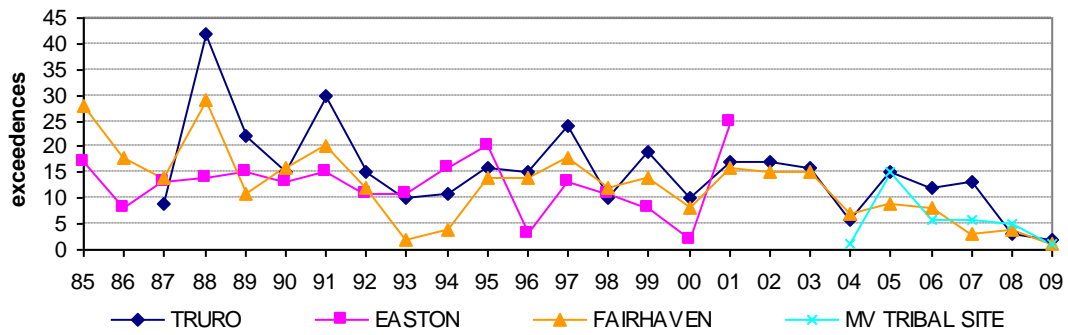
SITE ID	TOWN	ADDRESS	DESIGN VALUE 2006 - 2008
250010002	Truro	FOX BOTTOM AREA	0.079
250034002	Adams	MT GREYLOCK SUMMIT	-
250051002	Fairhaven	LEROY WOOD SCH	0.08
250070001	Aquinnah	HERRING CREEK RD, OFF STATE RD AT AQUINNAH (GAY HEAD)	0.083
250092006	Lynn	390 PARKLAND	0.081
250094004	Newbury	SUNSET BLVD	0.078
250095005	Haverhill	WASHINGTON ST-CONSENTINO SCHOOL	0.079
250130008	Chicopee	ANDERSON RD AFB	0.088
250150103	Amherst	N PLEASANT ST	0.075
250154002	Ware	QUABBIN SUMMIT	0.084
250170009	Chelmsford	11 TECHNOLOGY DRIVE, EPA NEW ENGLAND REGIONAL LAB	0.075
250171102	Stow	US MILITARY RES	0.078
250213003	Milton	BLUE HILL OBS	0.082
250250041	Boston	LONG ISLAND	-
250250042	Boston	HARRISON AV	0.067
250270015	Worcester	WORC AIRPORT	0.082

### 8-hour Ozone Exceedance Trends

Exhibit 5B-5 shows the long-term trends of 8-hour ozone exceedances for each site based on the 0.075 ppm 8-hour standard set in 2008.

Exhibit 5B-5  
8-hour Ozone Exceedance Trends 1985 – 2009  
Standard = 0.075 ppm

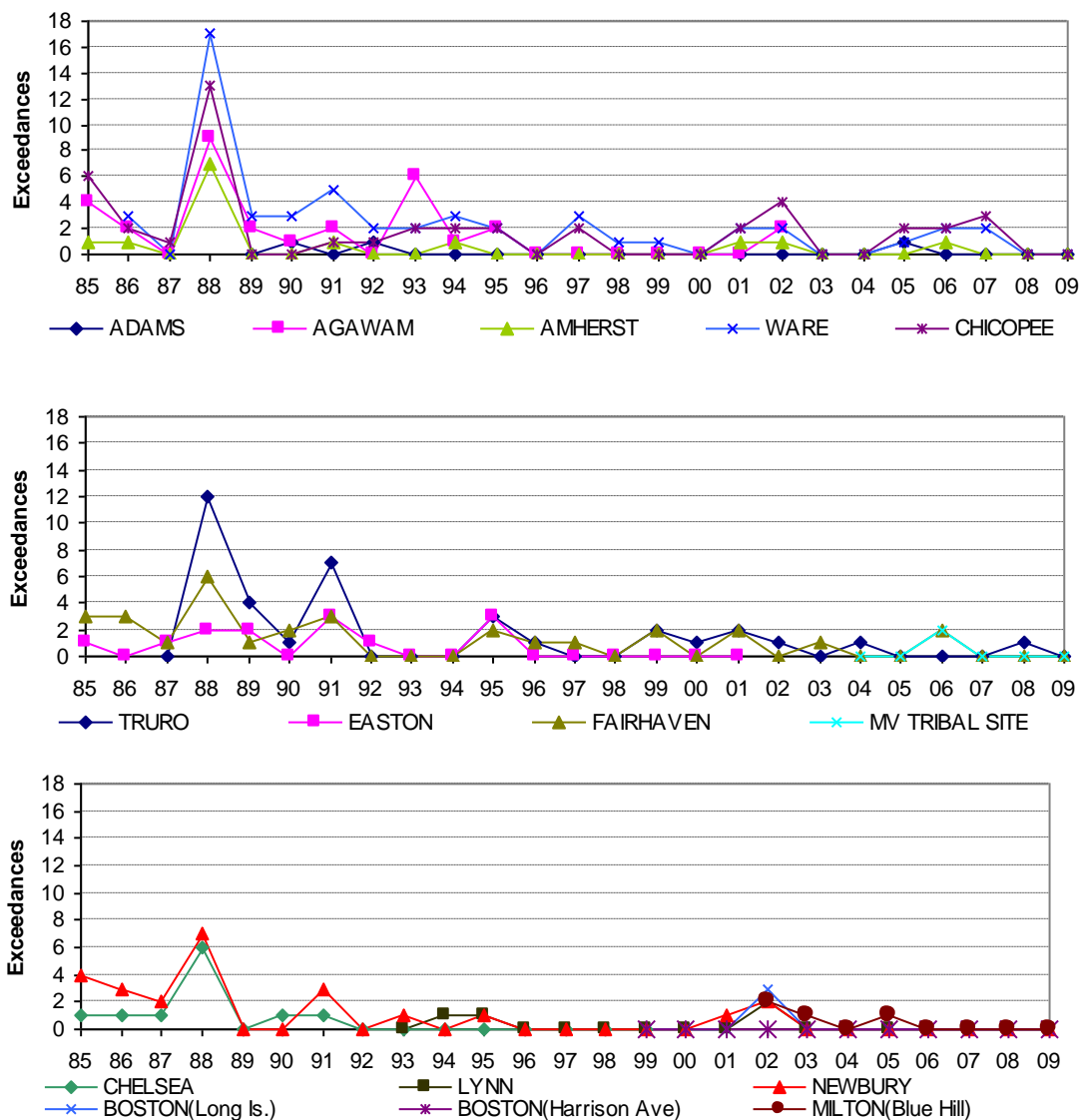


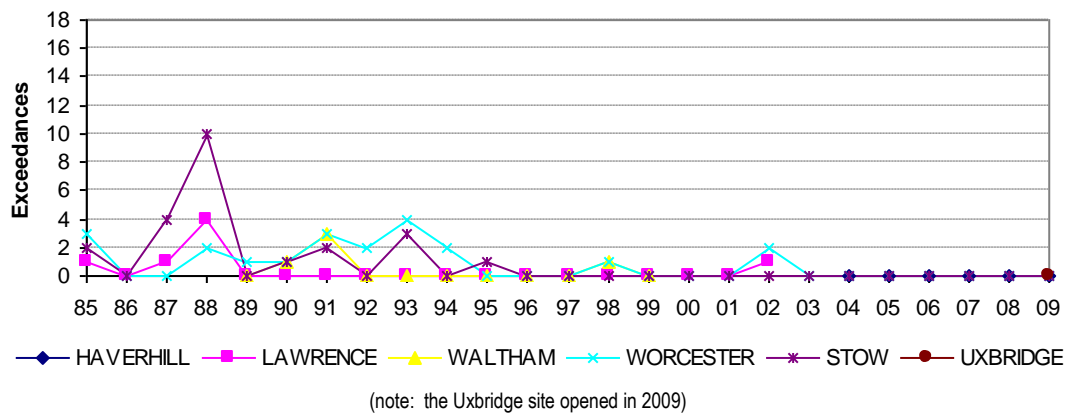


## 1-hour Ozone Exceedance Trends

As a point of reference, the ozone exceedance trends for the former 1-hour standard at each monitoring site are shown below. This standard was revoked in 2005.

Exhibit 5B-6  
1-hour Ozone Exceedance Trends 1985 – 2009  
Standard = 0.12 ppm (revoked June 15, 2005)





## Exceedances by Site in Massachusetts and Downwind States

Exhibit 5B-7 shows the number of exceedances of the 8-hour standard in the years 2007-2009 for each ozone monitor in Massachusetts and in downwind sites in Rhode Island, New York, Maine, New Hampshire, and Connecticut, into which ozone and ozone precursors are transported from Massachusetts.

EXHIBIT 5B-7  
MEASURED OZONE EXCEEDANCES IN MA AND DOWNWIND STATES 2007-2009

STATE	SITE ID	CITY	ADDRESS	CMSA	MSA NAME	CITY POPULATIONL	# EXCEEDANCES		
							07	08	09
MA	250010002	Truro	Fox Bottom Area	Not in a CMSA	Not in a MSA	1486	14	5	2
MA	250031002	Truro	Mt Greylock Summit	Not in a CMSA	Not in a MSA	6857	14	5	2
MA	250051002	Fairhaven (Town of)	Leroy Wood School	Boston- Worcester- Lawrence MA-NH- ME-CT	New Bedford, MA	15759	4	4	1
MA	250092006	Lynn	390 Parkland	Boston- Worcester- Lawrence MA-NH- ME-CT	Boston, MA-NH	89050	56	24	8
MA	250094004	Newbury	Sunset Blvd	Boston- Worcester- Lawrence MA-NH- ME-CT	Boston, MA-NH	4529	20	10	4
MA	250095005	Haverhill	Consentino School	Boston- Worcester- Lawrence MA-NH- ME-CT	Lawrence, MA- NH	58969	39	9	3
MA	250130008	Chicopee	Anderson Rd Afb	Not in a CMSA	Springfield, MA	54653	80	32	16
MA	250150103	North Amherst	N Pleasant St	Not in a CMSA	Springfield, MA	6019	9	2	1
MA	250154002	Ware (census name for Ware Center)	Quabbin Summit	Not in a CMSA	Springfield, MA	6174	68	28	20
MA	250170009	Chelmsford (Chelmsford Center)	11 Technology Drive, EPA New England Region	Boston- Worcester- Lawrence MA-NH- ME-CT	Lowell, MA-NH	31174	36	4	4

MA	250171102	Stow	Us Military Res	Boston-Worcester-Lawrence MA-NH-ME-CT	Boston, MA-NH	5144	11	3	3
MA	250213003	Milton	Blue Hill Observatory	Boston-Worcester-Lawrence MA-NH-ME-CT	Boston, MA-NH	26062	32	8	6
MA	250250041	Boston	Long Island	Boston-Worcester-Lawrence MA-NH-ME-CT	Boston, MA-NH	589141	6	2	8
MA	250250042	Boston	Harrison Av	Boston-Worcester-Lawrence MA-NH-ME-CT	Boston, MA-NH	589141	18		
MA	250270015	Worcester	Worcester Airport	Boston-Worcester-Lawrence MA-NH-ME-CT	Worcester, MA	172648	20	8	4
ME	230052003	Cape Elizabeth (Town of)	Two Lights State Park	Not in a CMSA	Portland, ME	7838	8	2	2
ME	230090102	Bar Harbor (census name for Bar Harbor Center)	Top Of Cadillac Mountain	Not in a CMSA	Not in a MSA	2680	12	2	3
ME	230090103	Not in a city	Mcfarland Hill-Air Pollutant Research Si	Not in a CMSA	Not in a MSA		20		4
ME	230112005	Gardiner	Pray Street School	Not in a CMSA	Not in a MSA	6198	6		
ME	230130004	Not in a city	Port Clyde, Marshall Point Lighthouse	Not in a CMSA	Not in a MSA		6		2
ME	230173001	Not in a city	Route 5, North Lovell Dot	Not in a CMSA	Not in a MSA		3		
ME	230194008	Not in a city	Summit Of Rider Bluff (Wlbz Transmitter)	Not in a CMSA	Not in a MSA		3		1
ME	230310038	Not in a city	Plains Road, Hollis	Not in a CMSA	Not in a MSA		5	1	
ME	230312002	Not in a city	Ocean Ave/Parsons Way, Kennebunkport	Not in a CMSA	Not in a MSA		8	3	3
NH	330012004	Laconia	Green Street, Laconia	Not in a CMSA	Not in a MSA	16411	15		
NH	330050007	Keene	Railroad Street	Not in a CMSA	Not in a MSA	22563	6	2	
NH	330074001	Not in a city	Mt. Washington	Not in a CMSA	Not in a MSA		12	4	
NH	330074002	Not in a city	Camp Dodge, Route 16, Green's Grant	Not in a CMSA	Not in a MSA		1		
NH	330090010	Lebanon	Lebanon Airport	Not in a CMSA	Not in a MSA	12568	4	2	
NH	330110020	Manchester	Pearl St	Boston-Worcester-Lawrence MA-NH-ME-CT	Manchester, NH	107006	18		
NH	330111011	Nashua	Gilson Road	Boston-Worcester-Lawrence MA-NH-ME-CT	Nashua, NH	86605	18		

NH	330115001	Peterborough (Peterboro)	Pack Monadnock Summit	Not in a CMSA	Not in a MSA	2944	24	10	
NH	330131007	Concord	Hazen Drive	Not in a CMSA	Not in a MSA	40687	3		
NH	330150014	Portsmouth	Portsmouth, Peirce Island	Boston-Worcester-Lawrence ,A-NH-ME-CT	Portsmouth-Rochester NH-ME	20784	25	5	5
NH	330150016	Rye	Seacoast Science Center	Boston-Worcester-Lawrence MA-NH-ME-CT	Portsmouth-Rochester NH-ME	4508	9	4	2
NH	330190003	Claremont	South Street	Not in a CMSA	Not in a MSA	13151	10	2	
CT	90010017	Greenwich (Town Of)	Greenwich Point Park	New York-N New Jersey-Long Island NY-NJ-CT-PA	Stamford-Norwalk CT	59,578	10	14	1
CT	90011123	Danbury	Trailer, W. Connecticut State University	New York-N New Jersey-Long Island, NY-NJ-CT-PA	Danbury, CT	74,848	18	9	3
CT	90013007	Stratford (Town Of)	USCG Lighthouse , Prospect Street	New York-N New Jersey-Long Island, NY-NJ-CT-PA	Bridgeport, CT	50,541	15	6	2
CT	90019003	Westport	Sherwood Island State Park	New York-N New Jersey-Long Island, Y-NJ-CT-PA	Stamford-Norwalk, CT	25,749	8	10	2
CT	90031003	East Hartford	Mcauliffe Park		Hartford, CT	49,575	9	4	1
CT	90070007	Middletown	Conn. Valley Hosp., Shew Hall, Eastern D		Hartford, CT	43,167	15	8	1
CT	90090027	New Haven C	Criscuolo Park 1 James Street	New York-N New Jersey-Long Island, NY-NJ-CT-PA	New Haven-Meriden ,CT	848,006	6	2	
CT	90093002	Madison	Hammonasset State Park				13	7	1
CT	90131001	Stafford Tolland(Town Of)	Route 190, Shenipsit State Forest				18	7	3
CT	90050005	Cornwall	Mohawk Mountain		Not in a MSA		20	4	0
CT	90110124	Groton	Fort Griswold State Park		Norwich-New London, CT MSA		11	6	1
RI	440030002	West Greenwich	W. Alton Jones Campus Uri Parkerfield We		Providence-Fall River-Warwick, RI-MA	5,085	10	2	
RI	440071010	East Providence	Francis School, 64 Bourne Ave		Providence-Fall River-Warwick, RI-MA	48,688	11	4	1
RI	440090007	Narragansett (Census Name)	Tarzwell Road, Narragansett		Providence-Fall River-Warwick, RI-MA	12,088	9	4	0

## V. B-4 PAMS MONITORING

Ground-level ozone is unique because it is not emitted directly into the atmosphere from a stack or a tailpipe. Instead, it forms in the atmosphere from the photochemical reactions of other pollutants such as volatile organic compounds (VOCs) and nitrogen oxides (NO<sub>x</sub>). Ozone formation can occur many miles downwind from the source of the original emissions. These reactions occur in the presence of strong sunlight and are most pronounced during the hottest days of the summer.

PAMS (Photochemical Assessment Monitoring Station) is a special designation for enhanced monitoring stations that gather information on the ozone formation process. Instrumentation at these sites measures pollutants and meteorological parameters that are specific to the photochemical processes by which ozone is created in the atmosphere at ground level. This data makes it possible to assess ozone attainment progress independent of the meteorological variation that occurs between years.

In addition to the standard NAAQS pollutants (ozone, NO<sub>2</sub>, etc.) that are measured at other sites, other ozone precursors such as VOCs, including hydrocarbons and carbonyl compounds (e.g., aldehydes), are measured at PAMS stations on either an hourly basis or at regular intervals during June, July and August. NO<sub>x</sub> (total oxides of nitrogen) measurements (including NO<sub>x</sub>, NO and NO<sub>2</sub>) also are required at PAMS sites. Two Type 3 PAMS sites (Ware and Newburyport) measure NO<sub>y</sub> (total reactive oxides of nitrogen), which better characterizes atmospheric nitrogen reactions than traditional NO<sub>x</sub> measurements.

Meteorology is a critical component of ozone formation. Each PAMS site has a full complement of meteorological sensors including wind speed, wind direction, temperature, relative humidity, barometric pressure, solar radiation and at some sites, total ultraviolet light and precipitation. MassDEP also operates a sophisticated PAMS associated doppler radar atmospheric profiler at a non-PAMS site in Stow. This instrument measures temperature and wind profiles at different levels of the atmosphere that provide available information on upper level conditions that contribute to ozone formation and characterize meteorological effects on the long-range transport of air pollutants, especially ozone and its precursors. Although it was down for most of 2009 due to a final amplifier problem, it is operational for the 2010 ozone season.

Exhibit 5B-8  
Location and Description of PAMs Sites

SITE ID	CITY	ADDRESS	SCALE	REASON FOR MONITOR	MSA/CMSA	METEOROLOGICAL	POLLUTANTS
25-025-0041	BOSTON	LONG ISLAND	Urban	PAMS: Boston Type 2A (Maximum precursors)	Boston CMSA; Boston Metropolitan MSA	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , VOC Speciation (PAMS)
25-013-0008	CHICOPEE	ANDERSON ROAD	Urban	PAMS: Springfield Type 2 (Maximum Precursor)	Springfield MSA	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), VOC Speciation (PAMS), CARBONYLS (PAMS) PM Speciation, tCO

SITE ID	CITY	ADDRESS	SCALE	REASON FOR MONITOR	MSA/CMSA	METEOROLOGICAL	POLLUTANTS
25-009-2006	LYNN	390 PARKLAND	Urban	PAMS: Boston Type 2 (Maximum Precursor)	Boston CMSA; Boston Metropolitan MSA	FULL MET (WS/WD TEMP, RH, BP, SOLAR, & PRECIP )	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), VOC Speciation (PAMS), CARBONYLS (PAMS)
25-021-3003	MILTON	MILTON MA, BLUE HILL	Urban	PAMS: Boston Type 1 (Upwind Background)	Boston CMSA; Boston Metropolitan MSA	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , BAM <sub>2.5</sub> , VOC Speciation (PAMS)
25-009-4005	NEWBURYPORT	261 NORTHERN BLVD	Urban	PAMS Boston Type 3 (Maximum Ozone Concentration)	Boston CMSA; Boston Metropolitan MSA	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>A</sub> , NO <sub>Y</sub> , VOC Speciation (PAMS)
25-017-1102	STOW	US MILITARY	Re-regional	Maximum Ozone Concentration	Boston CMSA; Boston Metropolitan MSA	WS/WD, TEMP, RH, BP, SOLAR UPPER AIR PROFILER	O <sub>3</sub>
25-015-4002	WARE	QUABBIN SUMMIT	Urban	PAMS: Springfield Type 3 (Maximum Ozone Concentration)	Springfield MSA	FULL MET & PRECIP	O <sub>3</sub> , tSO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>A</sub> , NO <sub>Y</sub> , PM <sub>10</sub> (LV), IMPROVE, PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> , VOC Speciation (PAMS)

A Type 3 PAMS site was located at Newbury (25-009-4004) from 1995 to 2009.

## V. B-5 OZONE MONITORING TECHNOLOGY

### Ozone

MassDEP uses continuous ultraviolet (UV) light photometry to monitor ambient ozone concentrations. This is the Federal Automated Equivalent Method and there is no reason to change this equipment.

### PAMS

Automated hourly gas chromatographs (GCs) are operated at Lynn, Chicopee, Ware, and Newburyport. Massachusetts also collects eight, 3-hour carbonyl samples every 3<sup>rd</sup> day at the Type 2 sites during the PAMS season. Eight, 3-hour canister samples are collected on the 1-in-3 day schedule at the Milton and Boston PAMS sites during the PAMS season. MassDEP collects every 6<sup>th</sup> day 24-hour canister and carbonyl samples throughout the year at Chicopee and Lynn in compliance with the original PAMS regulations.

Although the canister collection and processing at the non-GC sites has proved to be labor intensive, the operation and maintenance of automated, hourly laboratory grade gas chromatographs at those sites also is labor intensive and difficult in the face of decreasing resources. MassDEP is interested in following developments that will make the collection of PAMS precursor data easier.

## V. B-6 ADEQUACY OF THE EXISTING MONITORING NETWORK

### EPA Requirements

As demonstrated in Exhibit 5B-9, MassDEP's ozone monitoring network meets minimum EPA requirements.

Exhibit 5B-9  
Minimum Ozone Monitoring Requirements

CSA/MSA	POPULATION	DESIGN VALUE (max for CSA / MSA)	≥85% OF STD?	# MONITORS REQUIRED*	# MONITORS IN NETWORK	MAXIMUM CONCENTRATION SITE FOR EACH MSA or CSA
Boston-Worcester-Manchester, MA-RI-NH CSA	7,609,358	0.082	Yes	3	12	Stow, Newburyport
Pittsfield, MA Metro Area	129,288	na	No: (84 avg % 2006-8)	0	1	Adams
Springfield, MA Metro Area	698,903	0.088	Yes	2	3	Ware
Barnstable County, MA Metro Area	221,151	0.083	Yes	1	1	Truro

If the Design value is ≥85% of the standard:

- CSA/MSAs with a population of 4- 10 million require 3 monitors
- CSA/MSAs with a population of 350,000 - < 4 million require 2 monitors
- CSAs/MSAs with a population of 50,000 – 349,999 require 1 monitor

In accordance with EPA guidance, PAMS monitoring provides more comprehensive data on ozone air pollution in areas classified as serious, severe, or extreme nonattainment than would otherwise be achieved through the NCore and other monitoring sites. Although Springfield and Boston are currently classified as moderate nonattainment areas, EPA requires two PAMS sites for each of these CSA/MSAs. The sites have to meet the criteria in Exhibit 5B-10.

Exhibit 5B-10  
Minimum PAMS Monitoring Requirements

MEASUREMENT	WHERE REQUIRED	SAMPLING FREQUENCY (All daily except for upper air meteorology) <sup>1</sup>	SITES	
Speciated VOC <sup>2</sup>	Two sites per area, one of which must be a Type 2 site	During the PAMS monitoring period: (1) Hourly auto GC, or (2) Eight 3-hour canisters, or (3) 1 morning and 1 afternoon canister with a 3-hour or less averaging time plus Continuous Total Non-methane Hydrocarbon measurement.	<i>EPA Requirement:</i> -Hourly auto GC at • Lynn (Type 2) • Chicopee (Type 2) • Ware (Type 3) • Newburyport (Type 3)	<i>Beyond EPA requirement-</i> Every sixth day 24-hour canister samples throughout the year at: • Lynn • Chicopee -Eight 3-hour canisters every third day (on the one in three schedule) during PAMS season at: • Milton (Type 1 & 3) • Boston (Type 2a)
Carbonyl sampling	Type 2 site in areas classified as serious or above for the 8- hour ozone standard	3-hour samples every day during the PAMS monitoring period.	<i>Beyond EPA requirement (MA is classified as "moderate"):</i> -Eight 3-hour carbonyl samples every third day during PAMS Season -Every sixth day 24-hour carbonyl samples throughout the year at • Chicopee (Type 2) • Lynn (Type 2)	
NO <sub>x</sub>	All Type 2 sites	Hourly during ozone monitoring season.	<i>EPA Requirement:</i> • Boston (Type2A) • Chicopee (Type2) Lynn (Type 2)	<i>Beyond EPA requirement:</i> • Milton (Types 1 & 3) • Newburyport (Type 3) • Ware (Type 3)
NO <sub>y</sub>	One site per area at the Type 3 or Type 1 site	Hourly during ozone monitoring season.	Newburyport (Type 3) Ware (Type 3)	
CO (ppb level)	One site per area at a Type 2 site	Hourly during ozone monitoring season.	Chicopee (Type 2), Lynn (Type 2)	

MEASUREMENT	WHERE REQUIRED	SAMPLING FREQUENCY (All daily except for upper air meteorology) <sup>1</sup>	SITES
Ozone	All sites	Hourly during ozone monitoring season.	All Sites
Surface met	All sites	Hourly during ozone monitoring season.	All Sites
Upper air meteorology	One representative location within PAMS area	Sampling frequency must be approved as part of the annual monitoring network plan required in 40 CFR 58.10.	STOW

When the ozone and PAMS sites were originally established, MassDEP worked closely with EPA to ensure that the proper analyses were done to ensure that the each site met the network design requirements. Since population and pollution sources have not significantly changed since the mid 1990s MassDEP is confident that the ozone and PAMs sites still meet the appropriate design criteria.

MassDEP continues to participate in regional and national discussions designed to make sure the PAMS and ozone network is both efficient and relevant moving forward and continues to meet the needs of MassDEP and the Ozone Transport Commission for air pollution forecasting and ozone SIP development and implementation, and of MANE-VU for regional haze planning

### **Correlations, New Sites, Removal Bias Data**

EPA has developed tools for analyzing the need for new sites and potentially redundant sites. They include:

- Identifying potential new sites based on correlations between existing site measurements, distance between sites and the likelihood of the site exceeding a standard,
- Evaluating the correlation between site measurements, and
- Estimating the removal bias – the difference between the measured concentrations at a site and those that would be estimated for that site based on data from surrounding sites.

These tools produce files that display the information graphically as well as present the data in spreadsheets and database files.

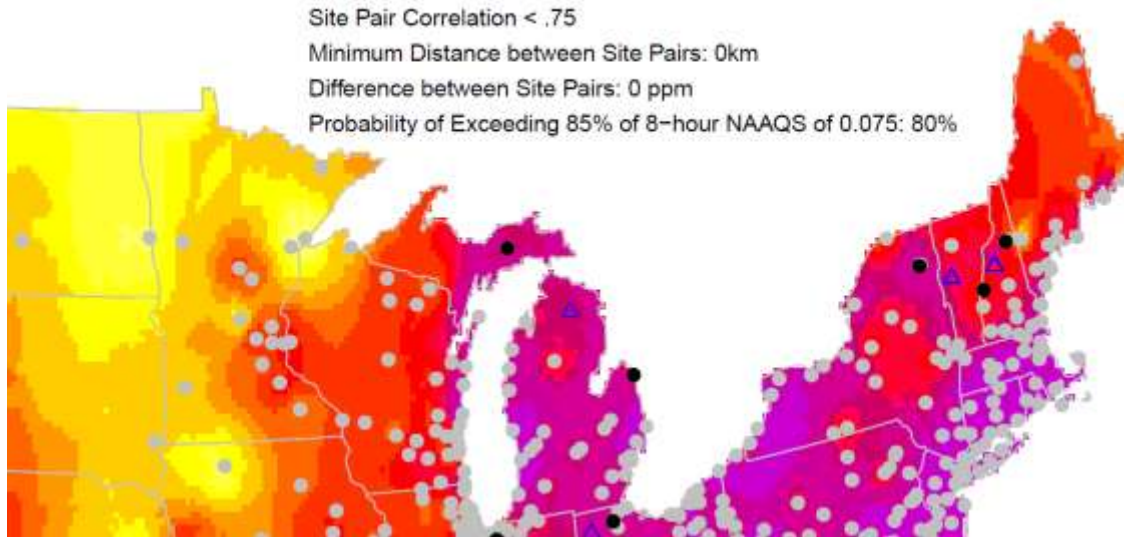
### New Sites Analysis

Exhibit 5B-11 shows the results of the new sites analysis. This tool identifies areas in the state mid-way between two monitors that have a lower correlation than the level used in the analysis.. The higher the desired correlation between sites, the more “new sites” the tool will suggest. MassDEP ran the tool for 2008 data for the ozone monitors at a correlation coefficient of 0.75.

The resulting maps have triangles at the suggested spot for new monitors, which is the midpoint between two adjacent monitors that do not meet the correlation test. Light dots indicate monitors that are correlated at or above selected correlation level. Black dots indicate monitors that have a lower correlation than the selected level.

Exhibit 5B-11  
New Sites Analysis

2008 Ozone sites

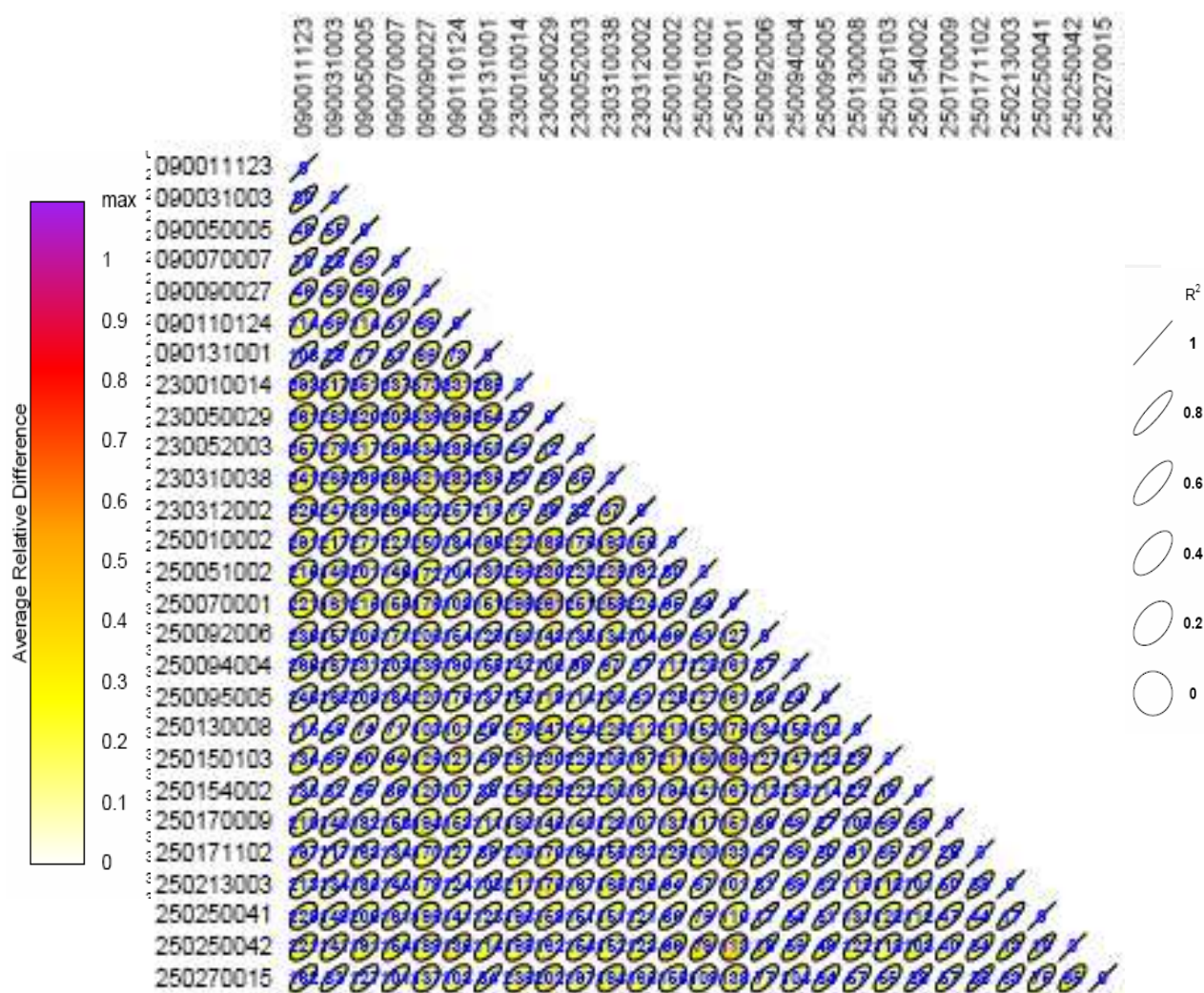


The data show that the ozone concentrations measured at monitors throughout the northeast measure values that are highly correlated with those measured by their closest neighbors. There is no apparent need for additional ozone sites in Massachusetts. These data are also available for other years and in data base and spreadsheet formats.

Site Correlation Analysis

Exhibit 5B-12 shows the correlation between ozone monitoring sites in Massachusetts for 2008. The narrower the ellipse, the higher the correlation between the two sites. The lighter the color the lower the difference between measured results. (The Massachusetts sites all begin with the number 25.) The analysis shows that there are several ozone sites that are highly correlated with each other. The data indicate that there are several ozone monitoring sites that are fairly well correlated with each other with low average relative difference. These data also are available for other years, and in a format that has been entered into an Access data base.

Exhibit 5B -12  
Correlation between MA Ozone Monitors2008



### Removal Bias Analysis

The final EPA tool calculates the removal bias. Exhibit 5B-13 shows the removal bias that would result from eliminating each ozone monitor. It is a measure of the difference between the ambient concentration a monitor measures and the ambient concentration for that location that would be extrapolated from the levels measured at nearby monitors. A positive average bias would mean that if the site being examined was removed the neighboring sites would indicate that the estimated concentration at the site would be larger than the measured concentration. If the site is solid colored it means that the removal bias is not statistically different.

The data show that while there are statistically significant differences between what would be predicted at a site and what the site measures, the differences are not very high. The light color of the dots indicates that the differences are less than plus or minus 5 ppb at all sites except

North Adams (the top of Mount Greylock) and Boston, where they are less than plus or minus 10 ppb.

Exhibit 5B-7  
Ozone Monitor Removal Bias



## V. B-7 MONITORING GAPS

MassDEP's analysis indicates that there is no need for additional ozone or PAMs monitors in Massachusetts. While it is possible that some ozone sites could be eliminated, all except the following five monitors measure other contaminants in addition to ozone:

- 25-003-4002 Adams
- 25-015-0103 Amherst
- 25-005-1002 Fairhaven
- 25-017-4003 Uxbridge
- 25-027-0015 Worcester Airport

Of these five sites Uxbridge and Worcester provide important meteorological data that are not available elsewhere, and Adams is the only site in far western Massachusetts.

Looking toward the future of the PAMs program, a holistic strategy that includes PAMS measurements at fewer but more enhanced air monitoring stations is being developed by EPA. EPA regulations in 2006 reduced the number of PAMS sites in each area from the original maximum five sites per network to two sites.

## V. C Carbon Monoxide (CO)

### V. C-1 CO NETWORK DESCRIPTION

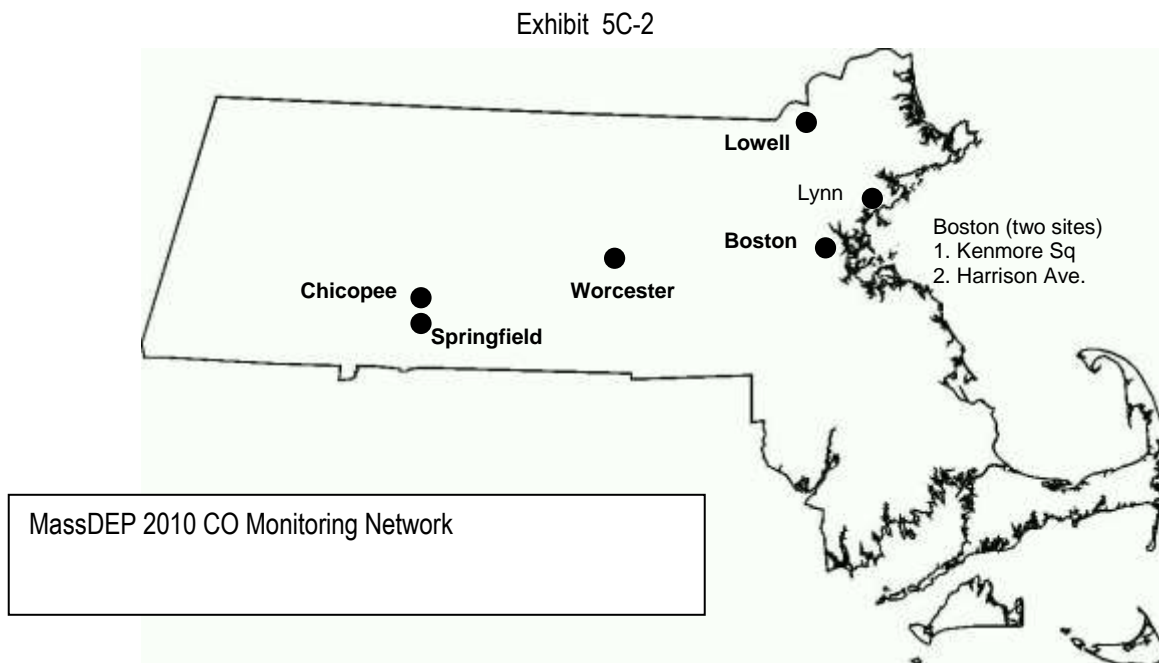
MassDEP currently operates 7 carbon monoxide (CO) monitors in 5 cities in Essex, Hampden, Middlesex, Suffolk, and Worcester Counties. The network employs full-scale, NAAQS compliance instruments that measure 0 to 50 ppm at 4 locations and trace-level instruments that measure from 0 to 5 parts per million at 3 sites. Trace-level monitors are used at locations where CO measurement is of interest, but where levels are expected to be less than 2 parts per million. The trace-level CO instruments at Lynn and Chicopee (Type 2 PAMS sites) are designed to track the commuting plume. The third trace-level CO instrument is at the designated NCore site (Boston-Harrison Avenue) where it provides more precise information on CO trends.

Exhibit 5C-1 lists the location, purpose, description and EPA scale of each of the CO monitoring stations.

Exhibit 5C-1  
CO Monitoring Network Description

SITE ID	CITY	COUNTY	ADDRESS	SCALE OF CO MONITOR	REASON FOR CO MONITOR	YEAR ESTABLISHED	MSA/CMSA	POLLUTANTS
25-009-2006	LYNN	ESSEX	390 PARKLAND	Urban		1/1/1992	Boston CMSA; Boston Metropolitan MSA	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> , VOC (TOXICS), VOC (PAMS), CARBONYLS (PAMS)
25-013-0008	CHICOPEE	HAMPDEN	ANDERSON ROAD	Urban	Population Exposure	1/1/1983	Springfield MSA	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY)(2), VOC (PAMS), CARBONYLS (PAMS) PM <sub>2.5</sub> SPECIATION
25-013-0016	SPRINGFIELD	HAMPDEN	LIBERTY STREET	Middle	-Population Exposure -Maximum Concentration	4/1/1988	Springfield MSA	CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (2) (3-DAY), BAM <sub>2.5</sub> , BLACK CARBON
25-017-0007	LOWELL	MIDDLESEX	OLD CITY HALL	Middle	-Maximum Concentration -Population Exposure	7/17/1981	Boston CMSA; Lowell MSA	CO
25-025-0002	BOSTON	SUFFOLK	KENMORE SQUARE	Middle	-Highest Concentration -Population Exposure	1/1/1965	Boston CMSA; Boston Metropolitan MSA	CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> (LV), PM <sub>2.5</sub> (3-DAY)
25-025-0042	BOSTON	SUFFOLK	HARRISON AVENUE	Middle	Population Exposure	12/15/1998	Boston CMSA; Boston Metropolitan MSA	O <sub>3</sub> , tCO, tSO <sub>2</sub> , Pb, NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>y</sub> , PM <sub>10</sub> (LV) (2), PM <sub>2.5</sub> (3-DAY) (2), BAM <sub>2.5</sub> , VOC (TOXICS), CARBONYLS (6th-DAY), BLACK CARBON NCore, Speciation, PM <sub>10</sub> (2: HV & TOXICS), PM <sub>coarse</sub> , Cr6+, PAHS
25-027-0023	WORCESTER	WORCESTER	SUMMER STREET	Middle	Population Exposure	1/1/2004	Boston CMSA; Worcester MSA	CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> (LV), PM <sub>2.5</sub> (2) (3-DAY), BAM <sub>2.5</sub>

Exhibit 5C-2 shows the location of each of the CO monitors.



## V. C-2 CO DATA

The last violation in the state of the CO NAAQS occurred in 1986. In 2000, MassDEP formally requested that EPA re-designate the cities of Lowell, Springfield, Waltham, and Worcester as attainment for CO since the CO monitoring data for those cities had been below the standard for many years. With the re-designation of these cities to CO attainment in April 2002, the entire state became attainment for the CO standard.

### 2009 Summary Data

Exhibit 5C-3 summarizes 2009 CO data. All of the sites achieved the requirement of 75% or greater data capture for the year.

Exhibit 5C-3  
2009 CO Monitoring Data Summary

SITE ID	CITY	COUNTY	ADDRESS	% OBS	1ST MAX 1-HR	2ND MAX 1-HR	OBS >35	1ST MAX 8-HR	2ND MAX 8-HR	OBS >9
25-025-0002	Boston	Suffolk	KENMORE SQUARE	80	1.4	1.4	0	1.1	1	0
25-025-0042	Boston	Suffolk	HARRISON AVENUE	97	2.6	2.4	0	1.5	1.2	0
25-017-0007	Lowell	Middlesex	MERRIMACK STREET	93	1.8	1.8	0	1.6	1.6	0
25-009-2006	Lynn	Essex	390 PARKLAND	96	0.9	0.8	0	0.6	0.6	0
25-013-0016	Springfield	Hampden	LIBERTY PARKING-LOT	93	2.4	2.2	0	1.9	1.8	0
25-027-0023	Worcester	Worcester	SUMMER STREET	93	2.7	2.4	0	2	1.9	0

Standards: 1-hour = 35 ppm      8-hour = 9 ppm

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**  
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER. **% OBS** = DATA CAPTURE PERCENTAGE. **1<sup>ST</sup>, 2<sup>ND</sup> MAX 1-HR** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED. **OBS > 35** = NUMBER OF 1-HR AVG. GREATER THAN 35 PPM (1-HR STANDARD). **1<sup>ST</sup>, 2<sup>ND</sup> MAX 8-HR** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED. **OBS > 9** = NUMBER OF 8-HR AVG. GREATER THAN 9 PPM (8-HR STD).

## CO Design Values

The design value is a statistic that describes the air quality measured by a monitor relative to the National Ambient Air Quality Standards (NAAQS) in order to classify attainment and nonattainment areas, assess progress towards meeting the NAAQS, and develop control strategies. Design values are defined in EPA guidance and are based on the NAAQS in 40 CFR Part 50. They often require multiple years of data that help to ensure a stable indicator. EPA computes and publishes design values for each monitor annually.

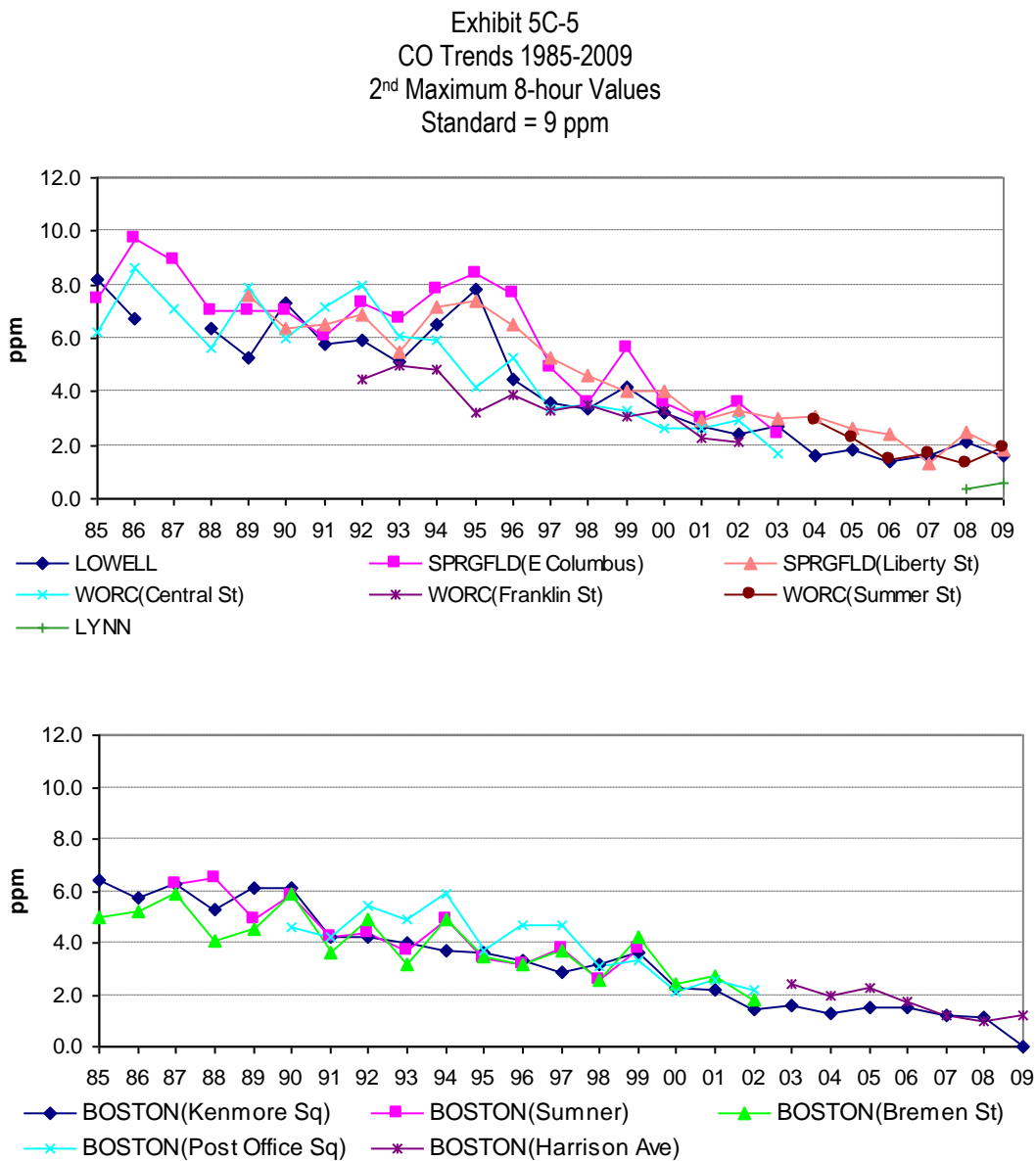
Exhibit 5C-4 shows design values for 2008 for CO. The 8-hour NAAQS for CO is 9 parts per million (ppm) not to be exceeded more than once per year. The design value is the highest annual second maximum non-overlapping 8-hour concentration during the most recent two years. The 1-hour NAAQS for carbon monoxide is 35 ppm not to be exceeded more than once per year. The design value is the highest annual second maximum 1-hour concentration during the most recent two years. Massachusetts is well below both the 8-hour and 1-hour CO standards.

Exhibit 5C-4  
2008 Design Values for CO

SITE ID	CITY	SITE ADDRESS	2008 DESIGN VALUE	
			8 HOUR	1 HOUR
250130016	SPRINGFIELD	LIBERTY STREET	3.4	3.4
250170007	LOWELL	OLD CITY HALL	3.2	3.2
250250002	BOSTON	KENMORE SQUARE	1.6	1.6
250250042	BOSTON	HARRISON AVENUE	2.0	2.0
250270023	WORCESTER	SUMMER STREET	2.7	2.7

## CO Trends

The long-term trends for each CO site are shown in Exhibit 5C-5.



## V. C-3 TECHNOLOGY

MassDEP uses gas filter correlation (GFC) for monitoring CO. In addition, MassDEP has deployed several trace-level (low concentration range) CO monitors over the last few years. There is no reason to change to another measurement technology at this time.

## **V. C-4 ADEQUACY OF THE MONITORING NETWORK.**

### **EPA Requirements**

MassDEP has sited its CO monitors in full compliance with EPA requirements, guidance and approval. At this time, EPA regulations do not have a minimum network size for monitoring CO. However, continued operation of existing CO sites using FRM or FEM monitors is required until discontinuation is approved by EPA. Where CO monitoring is ongoing at least one site must be a maximum concentration site for that area under investigation. The Kenmore Square (Boston) monitor is a potential “hot spot” within a one or two block radius. The Summer Street (Worcester) and Liberty Street (Springfield) monitors represent inner city, urban background.

EPA is currently reviewing the NAAQS for CO. The monitoring requirements for CO may change if EPA promulgates a new CO standard.

## **V. C-5 REDUNDANT MONITORS/MONITORING GAPS**

EPA has indicated that it will approve the shutdown of the CO monitor at Old City Hall in Lowell contingent upon its approval of MassDEP’s CO maintenance plan revision for Lowell. MassDEP will continue to operate the site until the CO maintenance plan revision is approved and MassDEP is certain that any new proposed CO NAAQS would not require new monitoring in Lowell or a nearby or similar location.

## V. D Sulfur Dioxide (SO<sub>2</sub>)

### V. D-1 SO<sub>2</sub> NETWORK DESCRIPTION

MassDEP currently operates 6 sulfur dioxide (SO<sub>2</sub>) monitors in 5 municipalities in Suffolk, Worcester, Bristol, Hampden and Hampshire Counties.

Four monitors are used for comparison with the SO<sub>2</sub> standards. Two instruments are configured to measure at a trace-level range. One trace-level instrument, Ware – Quabbin Summit, measures statewide background levels. The other trace-level instrument is at the NCore site (Boston-Harrison Avenue) where it will provide more precise information concentration information and better trends information.

Exhibit 5D-1 lists the location, purpose and description of the SO<sub>2</sub> monitoring stations and their EPA scales for SO<sub>2</sub> monitoring purposes.

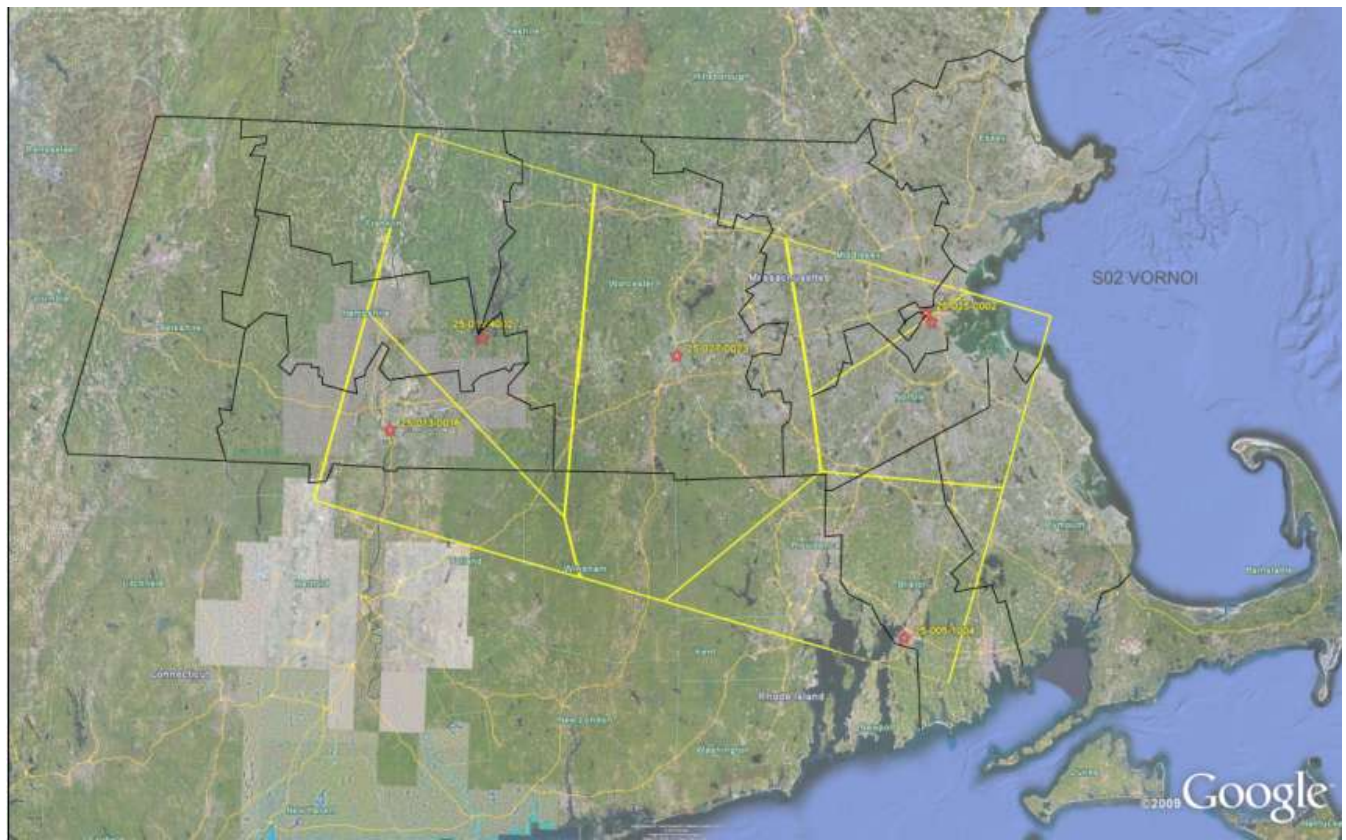
Exhibit 5D-1  
SO<sub>2</sub> Monitoring Network Description

SITE ID	CITY	COUNTY	ADDRESS	SCALE FOR SO <sub>2</sub> MONITOR	REASON FOR MONITOR	YEAR ESTABLISHED	MSA/CMSA
25-025-0002	BOSTON	SUFFOLK	KENMORE SQUARE	Middle	Population Exposure (Trace Level)	1/1/1965	Boston CMSA; Boston Metropolitan MSA
25-025-0042	BOSTON	SUFFOLK	HARRISON AVENUE	Neighborhood	Population Exposure	12/15/1998	Boston CMSA; Boston Metropolitan MSA
25-005-1004	FALL RIVER	BRISTOL	GLOBE STREET	Neighborhood	-Highest Concentration -Population Exposure	2/1/1975	Providence-Pawtucket-Fall River MSA
25-013-0016	SPRINGFIELD	HAMPDEN	LIBERTY STREET	Neighborhood	-Population Exposure -Maximum Concentration	4/1/1988	Springfield MSA
25-015-4002	WARE	HAMPSHIRE	QUABBIN SUMMIT	Regional	Population Exposure (Trace Level)	6/1/1985	Springfield MSA
25-027-0023	WORCESTER	WORCESTER	SUMMER STREET	Neighborhood	Population Exposure	1/1/2004	Boston CMSA; Worcester MSA

## V. D-2 COVERAGE AREA

The map in Exhibit 5D-2 shows the coverage area for the SO<sub>2</sub> monitors. It was prepared using EPA's Population Served Network Assessment Tool, as described in Section II.

Exhibit 5D-2  
Coverage Areas for SO<sub>2</sub> Monitors



## V. D-3 SO<sub>2</sub> DATA

Massachusetts has been in attainment of the annual, 24-hour, and 3-hour SO<sub>2</sub> standards since before 1985. On June 2, 2010, EPA replaced the current 0.50 ppm 3-hour standard with a 0.075 ppm 1-hour standard and revoked the annual and 24-hour standards.

### 2009 SO<sub>2</sub> Data Summary

Exhibit 5D-3 summarizes 2009 monitoring data for SO<sub>2</sub>. The 6 SO<sub>2</sub> sites in operation during 2009 achieved the required 75% data capture for the year.

Exhibit 5D-3  
2009 SO<sub>2</sub> Summary Data

SITE ID	CITY	COUNTY	ADDRESS	% OBS	1ST	2ND	#OBS >0.14	1ST	2ND	#OBS >0.5	1ST	2ND	ARITH MEAN
					MAX 24-HR	MAX 24-HR		MAX 3-HR	MAX 3-HR		MAX 1-HR	MAX 1-HR	
25-025-0002	Boston	Suffolk	KENMORE SQUARE	82	0.009	0.009	0	0.019	0.017	0	0.025	0.025	0.0025
25-025-0042	Boston	Suffolk	HARRISON AVENUE	96	0.013	0.012	0	0.028	0.023	0	0.033	0.030	0.0022
25-005-1004	Fall River	Bristol	659 GLOBE STREET	96	0.020	0.016	0	0.044	0.039	0	0.060	0.058	0.0028
25-013-0016	Springfield	Hampden	LIBERTY PARKING LOT	98	0.015	0.014	0	0.034	0.027	0	0.059	0.035	0.0031
25-015-4002	Ware	Hampshire	QUABBIN SUMMIT	93	0.009	0.009	0	0.015	0.014	0	0.016	0.016	0.0010
25-027-0023	Worcester	Worcester	SUMMER STREET	97	0.009	0.008	0	0.017	0.015	0	0.027	0.024	0.0016

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**

**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **% OBS** = DATA CAPTURE PERCENTAGE **1<sup>ST</sup>, 2<sup>ND</sup> MAX 24-HR, MAX 3-HR, MAX 1-HR** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **# OBS > 0.14** = NUMBER OF OBSERVATIONS ABOVE THE 24-HOUR STANDARD OF 0.14 PPM **# OBS > 0.50** = NUMBER OF OBSERVATIONS ABOVE THE 3-HOUR STANDARD OF 0.50 PPM **ARITH MEAN** = ANNUAL ARITHMETIC MEAN (STANDARD = 0.03 PPM)

## SO<sub>2</sub> Design Values

The design value is a statistic that describes the air quality measured by a monitor relative to the National Ambient Air Quality Standards (NAAQS) in order to classify attainment and nonattainment areas, assess progress towards meeting the NAAQS, and develop control strategies. Design values are defined in EPA guidance and are based on the NAAQS in 40 CFR Part 50. They often require multiple years of data that help to ensure a stable indicator. EPA computes and publishes design values for each monitor annually.

Exhibit 5D-4 shows the 2008 design value for SO<sub>2</sub>. The annual NAAQS for SO<sub>2</sub> is 0.03 parts per million (ppm) not to be exceeded for the year. The design value is the highest annual average of the most recent two years. The 24-hour average NAAQS for SO<sub>2</sub> is 0.14 ppm not to be exceeded more than once per year. The design value is the highest second maximum 24-Hour average of the most recent two years.

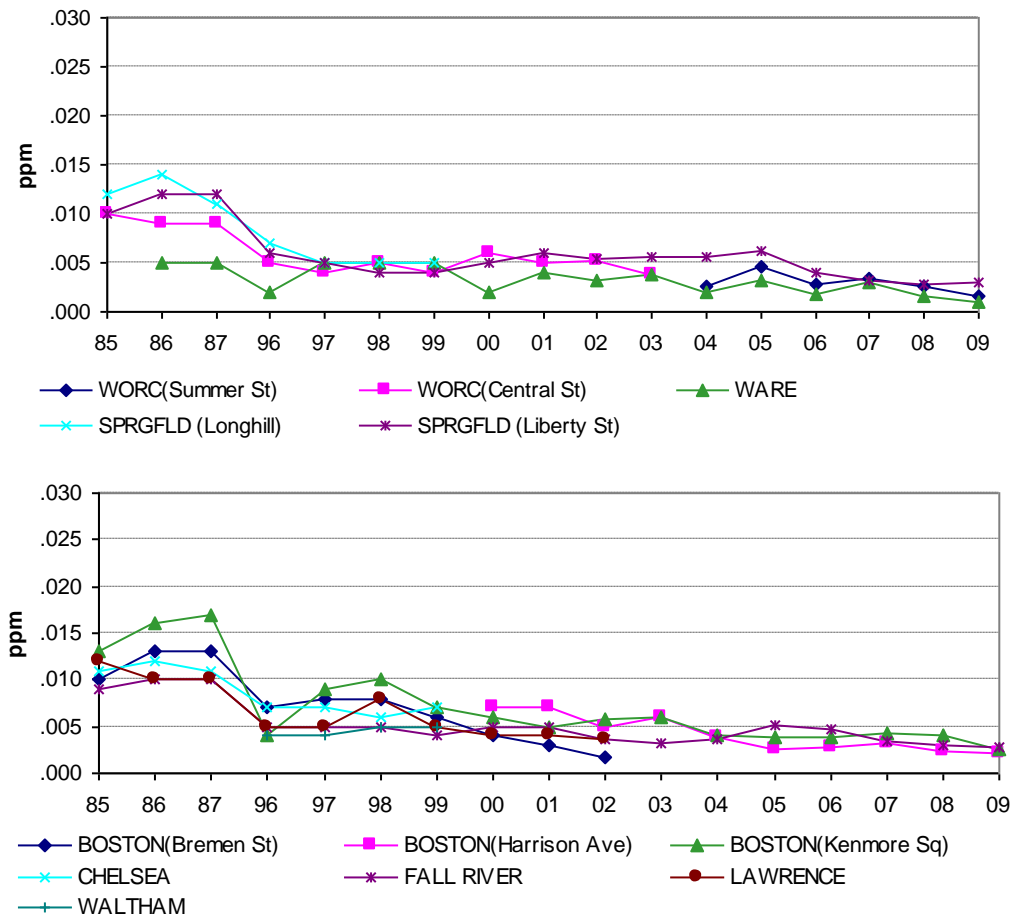
Exhibit 5D-4  
2008 SO<sub>2</sub> Design Value

SITE ID	SITE CITY	SITE ADDRESS	2008 DESIGN VALUE	
			ANNUAL	24-HOUR
250051004	FALL RIVER	GLOBE STREET	0.0034	0.0217
250130016	SPRINGFIELD	LIBERTY STREET	0.0032	0.0155
250154002	WARE	QUABBIN SUMMIT	0.0031	0.0107
250250002	BOSTON	KENMORE SQUARE	0.0042	0.0142
250250019	BOSTON	(Industrial Site) Long Island	0.0034	0.0113
250250020	BOSTON	(industrial Site) Dewar Street	0.0046	0.0122
250250021	BOSTON	(Industrial Site) 340 Bremen Street	0.0048	0.0138
250250040	BOSTON	(Industrial Site) 531a East First Street	0.0056	0.0146
250250042	BOSTON	HARRISON AVENUE	0.0032	0.0134
250270023	WORCESTER	SUMMER STREET	0.0035	0.0121

## SO<sub>2</sub> Trend Data

The long-term trends for each SO<sub>2</sub> site are shown in Exhibit 5D-5

Exhibit 5D-5  
SO<sub>2</sub> Trends 1985 –2009 Annual Arithmetic Means  
Standard = 0.03 ppm



## V. D-4 TECHNOLOGY

MassDEP uses an ultraviolet fluorescence continuous monitoring technology to measure ambient SO<sub>2</sub> concentrations. The same technology is used for both trace and standard monitors. There is no need to change to a different monitoring technology at this time.

## V. D-5 ADEQUACY OF THE MONITORING NETWORK

### EPA Requirements

The recently promulgated SO<sub>2</sub> NAAQS standard included revised monitoring requirements that must be implemented beginning in 2013. The new SO<sub>2</sub> monitoring requirements use a Population Weighted Emissions Index (PWEI) to determine the number of monitors required in each Core Based Statistical Area (CBSA) in the state. The formula for calculating the PWEI for each CBSA is:

$$[the \text{ sum of the population of each of the counties in the CBSA}] \times [the \text{ sum of the tons per year of SO}_2 \text{ in each of the counties in the CBSA}] / 1,000,000$$

The most recent National Emissions Inventory (NEI) published by EPA and the most recent U.S. Census Bureau population estimates are to be used as the source of the emissions and population data, respectively.

Exhibit 5D-6 shows the PWEI and number of SO<sub>2</sub> monitors for the state's CBSAs.

Exhibit 5D-6  
EPA Monitoring Requirements for SO<sub>2</sub>

COUNTY	JULY 1, 2009 POPULATION ESITMATES*			SO <sub>2</sub> TONS PER YEAR **	PWEI!	# REQUIRED SO <sub>2</sub> MONITORS***		
	COUNTY	CBSA	TOTAL MA COUNTIES IN CBSA			PER NEW RULE****	EXISTING	NEW NEEDED
Barnstable	221,151	Barnstable Town MSA	221,151	28,276	6,253	1	0	1
Berkshire	129,288	Pittsfield MSA	129,288	2,521	326	0	0	0
Bristol	547,433	Providence-New Bedford-Fall River, RI-MA MSA:	547,433	41,578	22,761	1	1	0
Worcester	803,701	Worcester MSA	803,701	6,837	5,495	1	1	0
Essex	742,582	Boston-Cambridge-Quincy, MA-NH MSA	4,165,815	44,810	186,670	2	2 but both in Boston	0
Middlesex	1,505,006							
Norfolk	666,303							
Plymouth	498,344							
Suffolk	753,580							
Hampden	471,081	Springfield MSA	627,125	11,236	7046	1	1	0
Hampshire	156,044							
	* Per US Census Bureau			** 2005 EPA National Emissions Inventory (NEI)	! *1,000,000	*** # SO <sub>2</sub> monitors required 1 if 5000<PWEI<100,000 2 if 100,000 <PWEI <1,000,000 3 if PWEI >1,000,000		

### V. D-6 MONITORING GAPS

As shown in the table above, MassDEP has sufficient monitors in each CBSA with the exception of Barnstable Town. In accordance with the new monitoring regulations, there should be a new community wide SO<sub>2</sub> monitoring site in this CBSA by June 2013. However, the need for a

monitor in Barnstable is based on the 2005 emissions for the Canal Electric Power Station. Recently, due in part to transmission improvements in southeastern Massachusetts and to the costs of operating these older units, SO<sub>2</sub> emissions have dropped significantly from the 28,276 tons used in the 2005 National Emissions Inventory due to significant cutbacks in the hours of operation. Exhibit 5D-7 presents operational and emissions data for 2008 -2010 for the two units at Canal Electric.

Exhibit 5D-7  
Total Operating Hours and Emissions for Canal Electric Units 1 & 2 2008 -2010

Year	Total Hours of Operation	Tons SO <sub>2</sub> emissions	PWEI @ 221,151 population
2008	9700	4600	1017
2009	2700	1500	332
2010 ytd	640	240 (320 estimate for the yestz0	71 (est)

On the basis of these lower emissions, which are expected to continue, a monitor would not be required for Barnstable.

## V. E Nitrogen Dioxide (NO<sub>2</sub>)

### V. E-1 NETWORK DESCRIPTION

MassDEP operates 11 NO<sub>2</sub> monitors in 8 municipalities located in Suffolk, Norfolk, Essex, Worcester and Hampden Counties. Because NO<sub>2</sub> is both a NAAQS pollutant and, along with other oxides of nitrogen, an ozone precursor, MassDEP operates 4 NO<sub>2</sub> sites for NAAQS compliance based on population exposure and operates NO<sub>2</sub> monitors at the 6 Photochemical Assessment Monitoring Stations (PAMS) and at 1 ozone site to measure ozone precursors.

As noted in the PAMS discussion, the former Newbury PAMS monitoring equipment has been moved to a new location in Newburyport.

Exhibit 5E-1: NO<sub>2</sub> Monitor Site Location, Description and Other Pollutants monitored

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR NO <sub>2</sub> MONITOR	YEAR ESTABLISHED	MSA/CMSA	POLLUTANTS
25-025-0002	BOSTON	SUFFOLK	KENMORE SQUARE	Middle	-Highest Concentration Population Exposure	1/1/1965	Boston CMSA; Boston Metropolitan MSA	CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> (LV), PM <sub>2.5</sub> (3-day)
25-025-0042	BOSTON	SUFFOLK	HARRISON AVENUE	-CO: middle scale -Others: Neighborhood	Population Exposure	12/15/1998	Boston CMSA; Boston Metropolitan MSA	O <sub>3</sub> , tCO, tSO <sub>2</sub> , Pb, NO, NO <sub>2</sub> , NO <sub>x</sub> , NOY, PM <sub>10</sub> (LV) (2), PM <sub>2.5</sub> (3-DAY) (2), BAM <sub>2.5</sub> , VOC (TOXICS), CARBONYLS (6-DAY), BLACK CARBON, NCore, Speciation, PM <sub>10</sub> (2: HV & TOXICS), PMcoarse, Cr6+, PAHS
25-025-0041	BOSTON	SUFFOLK	LONG ISLAND	Urban	PAMS: Boston Type 2A (Maximum Precursors)	12/1/1998	Boston CMSA; Boston Metropolitan MSA	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , VOC (PAMS)
25-013-0008	CHICOPEE	HAMPDEN	ANDERSON ROAD	Urban	PAMS: Springfield Type 2 (Maximum Precursor)	1/1/1983	Springfield MSA	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY)(2), VOC (PAMS), CARBONYLS (PAMS), Speciation
25-009-5005	HAVERHILL	ESSEX	WASHINGTON STREET	-PM <sub>2.5</sub> : Neighborhood -Others: Urban	Population Exposure	7/19/1994	Boston CMSA; Lawrence MSA	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub>
25-009-2006	LYNN	ESSEX	390 PARKLAND	Urban	PAMS: Boston Type 2 (Maximum Precursor)	1/1/1992	Boston CMSA; Boston Metropolitan MSA	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> , VOC (TOXICS), VOC (PAMS), CARBONYLS (PAMS)
25-021-3003	MILTON	NORFOLK	MILTON MA, BLUE HILL	Urban	PAMS: Boston Type 1 (Upwind Background)	4/2/2002	Boston CMSA; Boston Metropolitan MSA	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , BAM <sub>2.5</sub> , VOC (PAMS)

SITE ID	CITY	COUNTY	ADDRESS	SCALE	REASON FOR NO <sub>2</sub> MONITOR	YEAR ESTABLISHED	MSA/CMSA	POLLUTANTS
25-009-4005	NEWBURY-PORT	ESSEX	261 NORTHERN BLVD	Urban	PAMS Boston Type 3 (Maximum Ozone Concentration)	6/2010 (replaced the NEWBURY site)	Boston CMSA; Boston Metropolitan MSA	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>A</sub> , NO <sub>y</sub> , VOC (PAMS)
25-015-4002	WARE	HAMP-SHIRE	QUABBIN SUMMIT	Ozone: Urban PM: Neighbor-hood	-PAMS: Springfield Type 3 (Maximum Ozone Concentration)	6/1/1985	Springfield MSA	O <sub>3</sub> , tSO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>A</sub> , NO <sub>y</sub> , PM <sub>10</sub> (LV), IMPROVE. PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> , VOC (PAMS)
25-027-0023	WOR-CESTER	WOR-CESTER	SUMMER STREET	-CO: Middle Scale -Others: Neighbor-hood	Population Exposure	1/1/2004	Boston CMSA; Worcester MSA	CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> (LV), PM <sub>2.5</sub> (2) (3-DAY), BAM <sub>2.5</sub>

## V. E-2 COVERAGE AREA

Exhibit 5E-2 shows the coverage area of the NO<sub>2</sub> monitors, prepared by MassDEP using EPA's Population Served Network Assessment Tool, described in Section II.

Exhibit 5E-2  
NO<sub>2</sub> Monitor Coverage Area



## V. E-3 NO<sub>2</sub> DATA

### 2009 NO<sub>2</sub> Data Summary

A summary of the 2009 NO<sub>2</sub> data is shown in Exhibit 5E-3. There were 11 NO<sub>2</sub> sites in operation during 2009 in the state-operated monitoring network. All sites met the requirement of 75% data capture for the year with the exception of Newbury, which was shut down for construction.

Exhibit 5E-3  
Summary of 2009 NO<sub>2</sub> Monitoring Data

NITROGEN DIOXIDE (ppm)				1ST	2ND		
				%	MAX	MAX	ARITH
SITE ID	CITY	COUNTY	ADDRESS	OBS	1-HR	1-HR	MEAN
25-025-0002	Boston	Suffolk	KENMORE SQUARE	80	0.060	0.057	0.0201
25-025-0041	Boston	Suffolk	LONG ISLAND	95	0.045	0.041	0.0061
25-025-0042	Boston	Suffolk	HARRISON AVENUE	94	0.058	0.057	0.0180
25-013-0008	Chicopee	Hampden	ANDERSON RD AFB	95	0.046	0.045	0.0078
25-009-5005	Haverhill	Essex	CONSENTINO SCHOOL	96	0.048	0.046	0.0076
25-009-2006	Lynn	Essex	390 PARKLAND	95	0.047	0.046	0.0074
25-021-3003	Milton	Norfolk	BLUE HILL OBSERVATORY	96	0.045	0.033	0.0040
25-009-4004	Newbury	Essex	SUNSET BLVD	20	0.019	0.017	.0031*
25-013-0016	Springfield	Hampden	LIBERTY PARKING LOT	95	0.063	0.059	0.0149
25-015-4002	Ware	Hampshire	QUABBIN SUMMIT	95	0.036	0.035	0.0037
25-027-0023	Worcester	Worcester	SUMMER STREET	94	0.054	0.053	0.0143

NO <sub>2</sub> Primary Standard	
Level	Averaging Time
53 ppb	Annual (Arithmetic Average)
100 ppb	1-hour (To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb)
	Note: EPA adopted this standard January 22, 2010. Because it is new, monitored values for this standard do not appear in the NO <sub>2</sub> charts

#### ABBREVIATIONS AND SYMBOLS USED IN TABLE

**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **% OBS** = DATA CAPTURE PERCENTAGE **1<sup>ST</sup>, 2<sup>ND</sup> MAX 1-HR** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **ARITH MEAN** = ANNUAL ARITHMETIC MEAN

### NO<sub>2</sub> Design Values

The design value is a statistic that describes the air quality measured by a monitor relative to the National Ambient Air Quality Standards (NAAQS) in order to classify attainment and nonattainment areas, assess progress towards meeting the NAAQS, and develop control strategies. Design values are defined in EPA guidance and are based on the NAAQS in 40 CFR Part 50. They often require multiple years of data that help to ensure a stable indicator. EPA computes and publishes design values for each monitor annually.

Exhibit 5E-4 shows the 2008 for NO<sub>2</sub>. The NO<sub>2</sub> annual average NAAQS is 53 ppb. The design value is the highest average annual 1-hour average the past two years. The NO<sub>2</sub> 1-hour

maximum NAAQS is 100 ppb. The design value is the 3-year average of the annual 98<sup>th</sup> percentile of the daily 1-hour maximum.

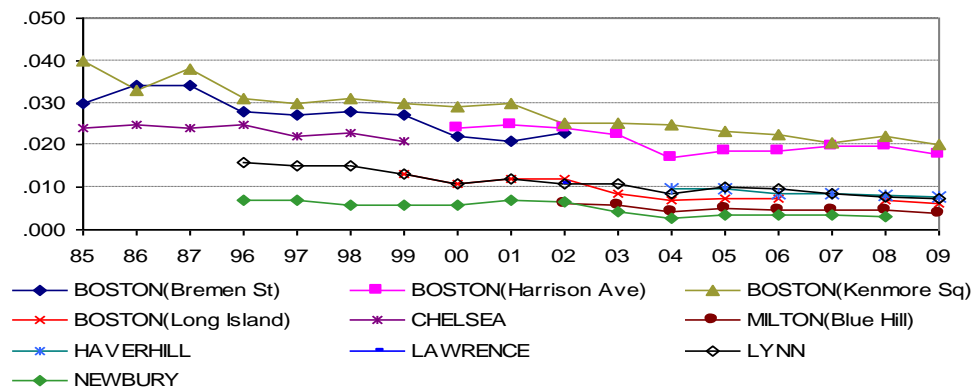
Exhibit 5E-4  
2008 Design Values for NO<sub>2</sub>

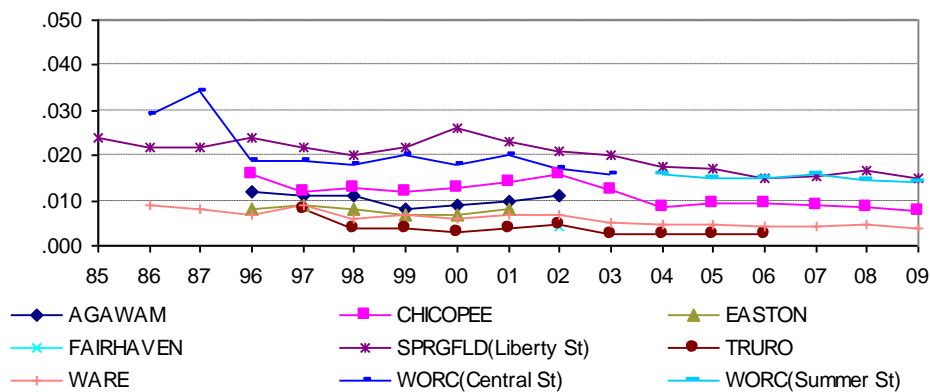
Site ID	Site City	Site Address	2008 Annual Average Design Value Std = 53 ppb	2009 1-hour maximum Design Value Std = 100 ppb
250092006	LYNN	390 PARKLAND	9	41
250095005	HAVERHILL	WASHINGTON STREET	8	
250130008	CHICOPEE	ANDERSON ROAD	9	
250130016	SPRINGFIELD	LIBERTY STREET	17	49
250154002	WARE	QUABBIN SUMMIT	5	29
250250002	BOSTON	KENMORE SQUARE	22	56
250250042	BOSTON	HARRISON AVENUE	20	
250270023	WORCESTER	SUMMER STREET	16	46

## NO<sub>2</sub> Trends Data

The long-term trends for each NO<sub>2</sub> site are shown in Exhibit 5E-5.

Exhibit 5E-5  
NO<sub>2</sub> Trends 1985 – 2009 Annual Arithmetic Means (Standard = 0.053 ppm)





## V. E-4 TECHNOLOGY

MassDEP presently uses continuous chemiluminescence-based instruments to measure NO<sub>2</sub>, NO<sub>x</sub>, NO<sub>y</sub> and NOA. There is no need to change the equipment at this time.

## V. E-5 ADEQUACY OF THE EXISTING MONITORING NETWORK

### EPA Monitoring Requirements

In February 2010, EPA promulgated a new 100 ppb 1-hour standard for NO<sub>2</sub> and established new ambient air monitoring requirements. The regulation requires states to evaluate air quality near heavily traveled roadways as well as to measure community-wide air quality. The number of “roadway” and “area wide” monitors required in each Core Based Statistical Area (CBSA) in the state depends upon the CBSA’s population and the Annual Average Daily Traffic counts (AADTs) for major roadways in the CBSA as follows:

- 1 roadway monitor if the CBSA population is between 500,000 and 2,500,000,
- 2 roadway monitors if the CBSA population greater than 2,500,000,
- 1 additional roadway if the AADT is greater than 250,000 for any road segment in the CBSA,
- 1 area wide monitor if the CBSA population is greater than 1,000,000.

Exhibit 5E-6 shows the number of NO<sub>2</sub> monitors required in each Massachusetts CBSA.

Exhibit 5E-6  
EPA NO<sub>2</sub> Monitoring Requirements

County	July 1 2009 Population (US Census Bureau Estimate)				# Required NO <sub>2</sub> Monitors				
	County	CBSA	Total: CBSA	Total: MA Counties in CBSA	Roadway based on population	Roadway based on AADT *	Community wide	Existing	New needed in CBSA
Barnstable	221,151	Barnstable Town MSA	221,151	221,151	0	0	0	0	0
Berkshire	129,288	Pittsfield MSA	129,288	129,288					
Bristol	547,433	Providence-New Bedford-Fall River, RI-MA MSA	1,600,642	547,433	1	0	0	0	1 roadway and 1 area unless in RI
Worcester	803,701	Worcester MSA	803,701	803,701	1	0	0	1 area	1 roadway
Essex	742,582	Boston-Cambridge-Quincy, MA-NH MSA	4,588,680	4,165,815	2	0	1	7 area	2 roadway (assumes none of existing qualify)
Middlesex	1,505,006								
Norfolk	666,303								
Plymouth	498,344								
Suffolk	753,580								
Hampden	471,081	Springfield MSA	698,903	627,125	1	0	0	2 area	1 roadway (assumes none of existing qualify)
Hampshire	156,044								

\* MassDOT data 2005-2007 shows no segment exceeding 250,000 AADTs

## V. E-6 A MONITORING GAPS

As shown in Exhibit 5E-6, MassDEP may need to install up to 6 new monitors by January 2013 as follows:

- 2 roadway sites in the Boston-Cambridge-Quincy, MA-NH MSA
- 1 roadway site in the Worcester MSA
- 1 roadway site in the Springfield MSA
- 1 roadway site and 1 community-wide site in the Providence-New Bedford-Fall River, RI-MA MSA (these 2 monitors could be sited in RI)

In addition, the EPA Regional Administrator may elect to site additional NO<sub>2</sub> monitors to help protect communities that are susceptible and vulnerable to NO<sub>2</sub>-related health effects.

None of MassDEP's existing NO<sub>2</sub> sites meet the 50 meters separation from the roadway criterion contained in the new regulations since a near-roadway monitor would not have been considered representative under the older siting criteria. MassDEP anticipates that it will not need to deploy an additional community-wide NO<sub>2</sub> monitor in the New Bedford-Fall River Area if Rhode Island operates one in the Providence Area.

Given current resource limitations, MassDEP faces difficult decisions regarding the deployment of its NO<sub>2</sub> monitors. Because of the complexity of NO<sub>2</sub> measurement, which requires subtracting the nitric oxide (NO) concentration from total nitrogen oxides (NO<sub>x</sub>) concentration,

NO<sub>2</sub> monitoring requires more attention than the other continuous gaseous pollutants. Seven of the 11 existing NO<sub>2</sub> sites are operated in support of ozone monitoring and the PAMS program, and not as NO<sub>2</sub> exposure locations, which limits options for redeployment. Also, the unique near-roadway specification may sharply limit the appropriate locations that are available for this type of monitoring.

## V. F LEAD (Pb)

### V. F-1 NETWORK DESCRIPTION

MassDEP has monitored lead at the Boston-Kenmore Square site for over 25 years. There was a three year hiatus in the mid-1990s when all lead monitoring in New England was discontinued because measured lead values had decreased dramatically after the phase-out of leaded gasoline. MassDEP resumed monitoring at the Boston-Kenmore Square site at the request of EPA for trends purposes. This has been the only site required to measure lead in New England.

In 2009 MassDEP moved the Kenmore Square lead sampler to the Boston-Harrison Avenue because of the downsizing of the Kenmore monitoring station.

### V. F-2 LEAD MONITORING DATA

Massachusetts has been in compliance for more than 25 years with the  $1.5 \mu\text{g}/\text{m}^3$  annual standard. In 2008, EPA lowered the annual NAAQS for lead from  $1.5 \mu\text{g}/\text{m}^3$  to  $0.15 \mu\text{g}/\text{m}^3$  and established new requirements for measuring lead. Based on monitoring data and analysis of Pb sources in the state, MassDEP believes that it will be in attainment of this new more stringent standard.

#### 2009 Pb Data Summary

A summary of the 2009 Pb data is shown in Exhibit 5F-1.

Exhibit 5F-1

	P						QTR1	QTR2	QTR3	QTR4	#		
	O					#	ARITH	ARITH	ARITH	ARITH	MEANS	1ST	2ND
SITE ID	C	PQAO	CITY	COUNTY	ADDRESS	OBS	MEAN	MEAN	MEAN	MEAN	> 1.5	MAX	MAX
25-025-0002	1	0660	Boston	Suffolk	KENMORE SQUARE	27	0.0087	0.0092			0	0.016	0.016
25-025-0042	1	0660	Boston	Suffolk	HARRISON AVENUE	19		.0040*	0.007	0.006	0	0.014	0.012

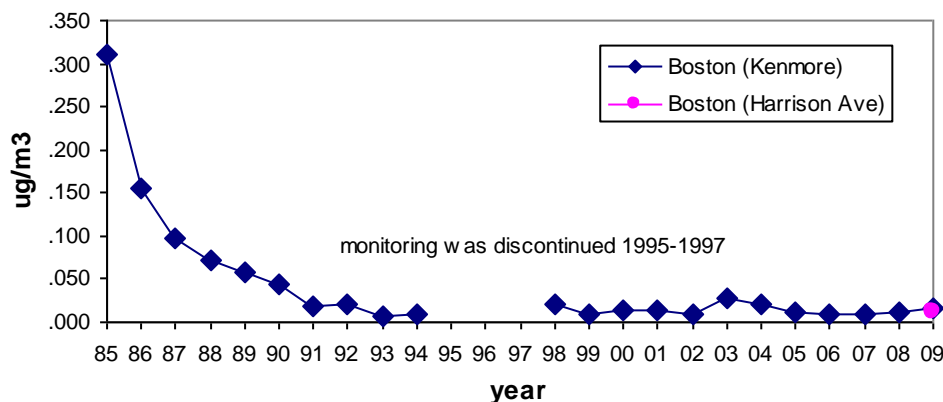
Note: The \* indicates that the mean does not satisfy summary criteria  
Standard:  $1.5 \mu\text{g}/\text{m}^3$  (Calendar Quarter Arithmetic Mean)

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**  
SITE ID = AIRS SITE IDENTIFICATION # OBS = # OBSERVATIONS QTR1,QTR2, QTR3, QTR4 ARITH MEAN = THE MEANS FOR THE 1<sup>ST</sup>, 2<sup>ND</sup>, 3<sup>RD</sup> AND 4<sup>TH</sup> CALENDAR QUARTERS # MEANS > 1.5 = THE NUMBER OF CALENDAR QUARTER MEANS GREATER THAN THE STANDARD ( $1.5 \mu\text{g}/\text{m}^3$ ) 1<sup>ST</sup>, 2<sup>ND</sup> MAX = THE 1<sup>ST</sup> AND 2<sup>ND</sup> MAXIMUM 24-HOUR VALUES

#### Pb Trend Data

Exhibit 5F-2 shows the trends in lead concentrations from 1985 – 2009.

Exhibit 5F-2  
Pb Concentrations 1985 – 2009  
Annual Arithmetic Mean  
Standard = 1.5 ug/m<sup>3</sup>



## V. F-3 TECHNOLOGY

MassDEP currently uses laboratory-based acid digestion and atomic absorption analysis of samples collected with a high-volume Total Suspended Particulate (TSP) sampler to measure ambient lead concentrations. The samples are taken every 6<sup>th</sup> day for 24 hours. In the future MassDEP will use the newly approved low-volume PM<sub>10</sub> samplers for Pb at Harrison Avenue in accordance with the new standard.

## V. F-4 ADEQUACY OF THE MONITORING NETWORK

### EPA Requirements

When EPA promulgated the new lead standard in 2008, the regulations required that by January 2011 states needed to operate 1 monitor in the vicinity of each source that emits 1 or more tons of lead per year and 1 monitor in each urban area with a population equal to or greater than 500,000. Subsequently EPA proposed to change the standard to 1 monitor in the vicinity of each source that emits 0.5 tons of lead per year and 1 monitor at the state's NCore site.

## V. F-5 MONITORING GAPS

According to the existing standard MassDEP would have to install a lead monitor in Springfield, the only urban area other than Metropolitan Boston that has 500,000 or more people. MassDEP has determined that it has no 1-ton per year or greater lead sources.

MassDEP believes it meets the EPA's revised lead monitoring regulations. MassDEP already has a lead monitor at its NCore Boston-Harrison Avenue site and MassDEP has determined that currently there are no lead emission sources that exceed the proposed 0.5 ton threshold for source-oriented ambient lead monitoring, even though EPA had identified several Massachusetts airports as

possibly exceeding the 0.5 ton threshold. MassDEP will continue to analyze its lead emissions data to ensure compliance with the source-specific lead monitoring requirements.

EPA provided fiscal year 2010 funding to MassDEP to begin lead measurements prior to the January 2011 deadline. MassDEP used this opportunity to obtain analyses for low-volume PM<sub>10</sub> samples taken at both the Harrison Avenue and Kenmore Square locations to determine the comparability of these two locations. MassDEP also is interested in measuring lead concentrations in the Springfield Area. Therefore, beginning in January 2011 MassDEP will measure lead using low-volume PM<sub>10</sub> samples from the monitors at Boston-Harrison Avenue and Springfield-Main Street.

## **V. G Meteorology**

### **V. G-1 NETWORK DESCRIPTION**

MassDEP operates the following types of meteorological monitors co-located at pollutant monitor sites:

- 13 – Barometric pressure (BP)
- 13 – Relative humidity (RH)
- 13 – Solar radiation (Solar)
- 14 – Temperature (TEMP)
- 13– Wind speed/wind direction (WS/WD)

In addition, Massachusetts maintains the following:

- 1 – Profiler (this monitor measures wind speed/wind direction and temperature at various altitudes, which aids in the analysis of pollutant transport)
- 2 – Precipitation

The Upper Air Profiler at the Stow monitoring site measures wind speed, wind direction and temperature at high elevations in the atmosphere. It is designed to characterize meteorological effects on the long-range transport of air pollutants, especially ozone and its precursors. Although the site was down for most of 2009 due to a final amplifier problem it is up and running for 2010.

In addition, the EPA National Air and Radiation Environmental Laboratory (EPA NAREL) set up a continuous atmospheric radiation sampler at the MassDEP Worcester-Summer Street station in 2009.

Finally, there are two acid rain monitors in Massachusetts that are part of the National Atmospheric Deposition Program (NADP):

- Ware –Quabbin Reservoir
- Truro

MassDEP provides funding to the University of Massachusetts to run the Quabbin site. The National Parks Service finances and operates the Cape Cod Truro site. MassDEP recently ceased operation of an acid rain monitoring station in Waltham due to resource constraints.

Exhibit 5G-1 describes all of the meteorological monitors operated by MassDEP.

Exhibit 5G-1  
Description of Existing Meteorological Monitoring Network

SITE ID	CITY	ADDRESS	METEOROLOGICAL	POLLUTANTS
25-025-0002	BOSTON	KENMORE SQUARE	TEMP	CO, SO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> (LV), PM <sub>2.5</sub> (3-day)
25-025-0041	BOSTON	LONG ISLAND	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , VOC (PAMS)
25-025-0042	BOSTON	HARRISON AVENUE	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , tCO, tSO <sub>2</sub> , Pb, NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>y</sub> , PM <sub>10</sub> (LV) (2), PM <sub>2.5</sub> (3-DAY) (2), BAM <sub>2.5</sub> , VOC (TOXICS), CARBONYLS (6th-DAY), BLACK CARBON -SPECIAL MONITORING: NCore, Speciation, PM10 (2: HV & TOXICS), PM <sub>coarse</sub> , Cr6+, PAHS
25-013-0008	CHICOPEE	ANDERSON ROAD	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY)(2), VOC (PAMS), CARBONYLS (PAMS) SPECIAL MONITORING: Speciation, tCO
25-005-1002	FAIRHAVEN	LEROY WOOD	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub>
25-009-5005	HAVERHILL	WASHINGTON STREET	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub>
25-009-2006	LYNN	390 PARKLAND	FULL MET & PRECIP	O <sub>3</sub> , tCO, NO, NO <sub>2</sub> , NO <sub>x</sub> , PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> , VOC (TOXICS), VOC (PAMS), CARBONYLS (PAMS)
25-021-3003	MILTON	MILTON MA, BLUE HILL	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , BAM <sub>2.5</sub> , VOC (PAMS)
25-009-4005	NEWBURYPORT	261 NORTHERN BLVD	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>A</sub> , NO <sub>y</sub> , VOC (PAMS)
25-017-1102	STOW	US MILITARY	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> SPECIAL MONITORING: UPPER AIR PROFILER
25-001-0002	TRURO	FOX BOTTOM AREA	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub> , IMPROVE, PM <sub>2.5</sub> (3-DAY)
25-027-0024	UXBRIDGE	366 E. HARTFORD AVE.	WS/WD, TEMP, RH, BP, SOLAR	O <sub>3</sub>
25-015-4002	WARE	QUABBIN SUMMIT	FULL MET & PRECIP	O <sub>3</sub> , tSO <sub>2</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , NO <sub>A</sub> , NO <sub>y</sub> , PM <sub>10</sub> (LV), IMPROVE, PM <sub>2.5</sub> (3-DAY), BAM <sub>2.5</sub> , VOC (PAMS)
25-027-0015	WORCESTER	WORCESTER. AIRPORT	WS/WD, TEMP	O <sub>3</sub>

## V. G-2 TECHNOLOGY

The Exhibit 5G-2 below summarizes the technology MassDEP uses to measure meteorology. There is no reason to change existing technology

Exhibit 5G-2  
Meteorological Monitoring Technology

PARAMETER	WORKSHEET ABBREVIATION	SAMPLING METHODOLOGY	ANALYTICAL METHOD	SAMPLE FREQUENCY	COMMENTS
Wind Speed/Direction	WS/ WD	Continuous Instrument	Ultrasonic Sensors or Spot Reading	Hourly	Eleven Meteorological Sites in State
Solar	SOLAR	Continuous Instrument	Pyranometer	Hourly	Eleven Meteorological Sites in State
Relative Humidity	RH	Continuous Instrument	Electronic Sensor	Hourly	Eleven Meteorological Sites in State
Ambient Temperature	TEMP	Continuous Instrument	Electronic Thermister	Hourly	Eleven Meteorological Sites in State
Barometric Pressure	BP	Continuous Instrument	Electronic Sensor	Hourly	Eleven Meteorological Sites in State
Precipitation	Precip	Continuous Instrument	Tipping Bucket	Hourly	Ware and Lynn Only
Upper Air Wind	Upper Air Profiler	Hourly Instrument	Radar Vectoring	Hourly	Stow Only
Upper Air Temperature	Upper Air Profiler	Hourly Instrument	Acoustic/ Radar Vectoring	Hourly	Stow Only

## V. G-3 MONITORING GAPS

MassDEP has access to all of the meteorological information needed to forecast air quality, including predicting ozone and PM<sub>2.5</sub> episodes, modeling emissions from individual sources, evaluating the transport of pollution (particularly ozone and its precursors), and creating wind roses.

## **V. H Cross-Cutting Technology Issues**

This section summarizes technology-related issues regarding MassDEP's monitoring network.

### **CALIBRATION**

- MassDEP's field calibrators are suitable for ozone and trace-level dilution as appropriate. The equipment is capable of automated quality control checks. MassDEP has an internal ozone generator-photometer.
- MassDEP's lab and field calibrators can generate Minimum Detection Level (MDL)-level concentrations (CO, SO<sub>2</sub>, and NO<sub>y</sub>).

### **ZERO AIR SOURCE**

- MassDEP's zero air source is compliant with NCore TAD recommendations. An ultra-pure air cylinder is used for occasional comparison to zero air source. The equipment has the capacity for 20+ LPM of dilution air.

### **DATA ACQUISITION SYSTEM**

- MassDEP's data system is capable of a digital system, remote diagnostics, and remotely enabled checks.

### **GAS CYLINDER STANDARDS**

- MassDEP's gas cylinders are suitable for the trace-level dilutions in accordance with Appendix A of 40 CFR Part 58 audit concentrations and EPA protocol certifications, and meet the special low-level standards needed for MDL concentrations (CO, SO<sub>2</sub>, and NO<sub>y</sub>).

### **METEOROLOGICAL CALIBRATION DEVICES**

- MassDEP's meteorological calibration devices have NIST (National Institute of Standards) traceability for required meteorological parameters. Sonic wind instruments must be shipped to the manufacturer annually for factory calibration.

### **SAMPLING MANIFOLD**

- MassDEP's sampling meets the standards of Appendix E of 40 CFR Part 58, including residence time <20 seconds, only glass or Teflon materials, and probe and monitor inlets of acceptable heights.

## AUDITING EQUIPMENT

MassDEP has:

- Independent calibrators
- Zero air source and gas standards compatible with trace-level specifications
- Independent meteorological and flow standards
- New dilution systems capable of generating EPA-required concentration levels

## OTHER

MassDEP has:

- Recent vintage Automated Gas Chromatograph systems for measuring VOC ozone precursors at 4 field sites and at its laboratory for analyzing field-procured VOC canister samples
- A robotic weighing device for PM<sub>2.5</sub> filters and a new environmental chamber is under construction
- A real-time website for displaying current air pollution concentrations to the public
- CDX-node connection for the routine transfer of the air quality data collected by the monitoring network